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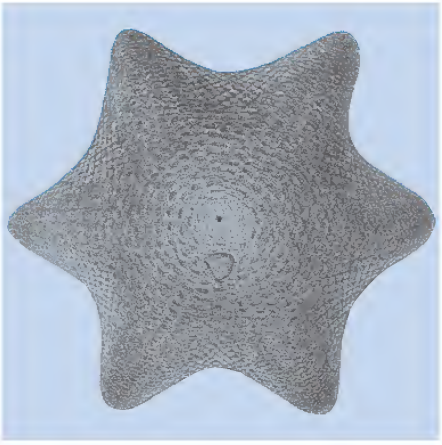

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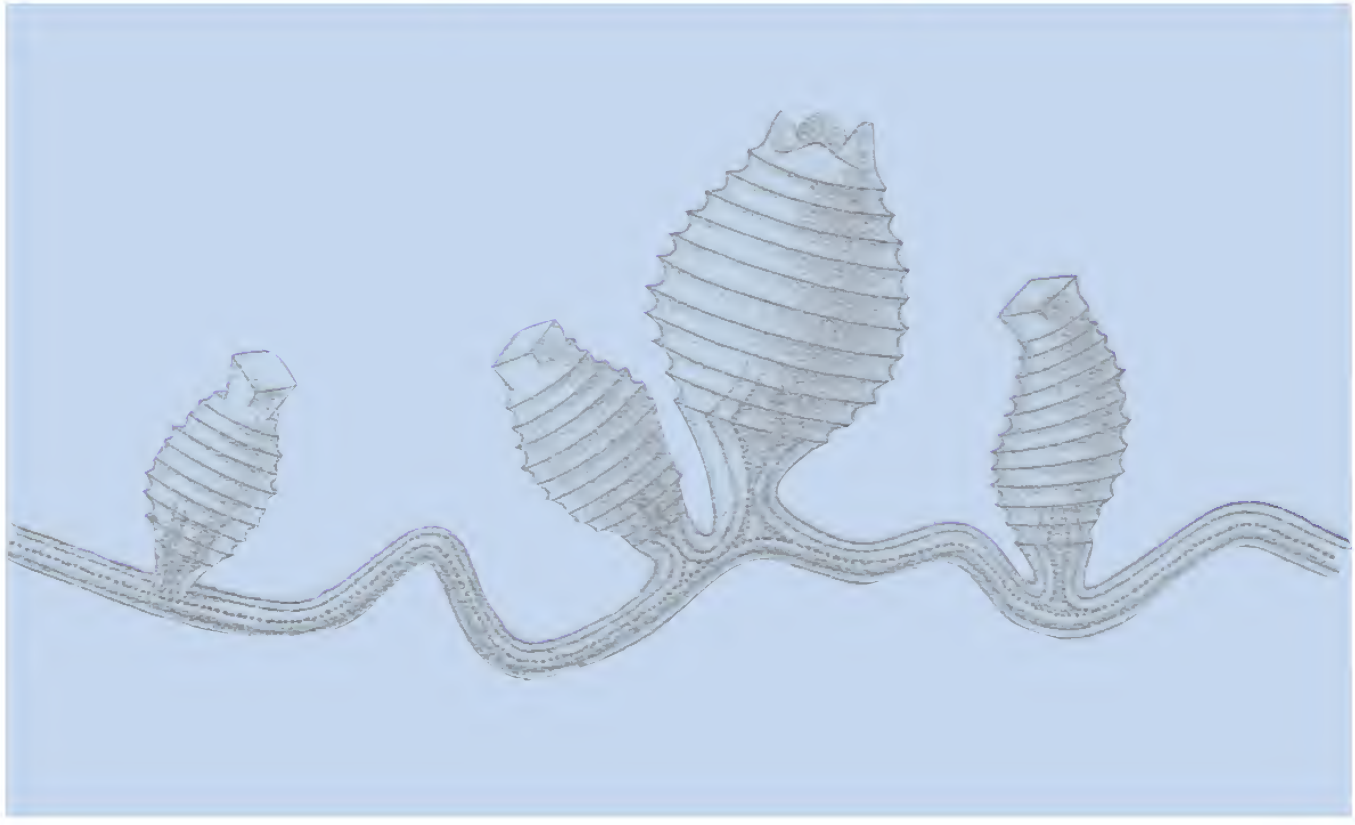

Memoirs of Museum Victoria Volume 60 Number 2 2003

Front cover illustrations. Top left: *Sphaeroma calcarea* Dana, 1853, a crustacean listed under *Exosphaeroma* by N. L. Bruce in this volume.

Top centre: *Asterina gunnii*, a seastar figured by F. McCoy in 1890 and discussed by P. M. O'Loughlin.

Bottom: *Calamphora parvula* Allman, 1888, representative of a hydroid genus reported from Macquarie Island by J. E. Watson.

Figures are from:

Allman, G. 1888. Report on the Hydroida dredged by H.M.S. *Challenger* during the years 1873–76. Part II. The Tubularinae, Corymorphinae, Campanularinae, Sertularinae and Thalamophora. *Report on the Scientific Results of the Voyage of H.M.S. Challenger 1873–76 (Zoology)* 23: 1–90.

Dana, J.D. 1853. Crustacea. Pp 696–805. *United States Exploring Expedition during the years 1838, 1839, 1840, 1841, 1842, under the command of Charles Wilkes, U.S.N.* C. Sherman, Philadelphia.

McCoy, F. 1878–1890. *Prodromus of the zoology of Victoria. Figures and descriptions of the living species of all classes of the Victorian indigenous animals.* Government Printer: Melbourne.

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MELBOURNE AUSTRALIA

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Figure captions should follow this example:

Figure 1. *Storthyngurella hirsuta* sp. nov., male, holotype: a, b, dorsal and lateral views of body; c, d, frontal and lateral views of cephalon.

References should be listed alphabetically at the end of the manuscript. Journal titles must be in full. References to books must give the year of publication, edition, name of publisher and city of publication. Use the style and punctuation in the following examples for articles, books and chapters:

Paulin, C.D. 1986. A new genus and species of morid fish from shallow coastal waters of southern Australia. *Memoirs of Museum Victoria* 47: 201–206.

Last, P.R., and Stevens, J.D. 1994. *Sharks and rays of Australia*. CSIRO Publishing: Melbourne. 513 pp.

Wilson, B.R., and Allen, G.R. 1987. Major components and distribution of marine fauna. Pp. 43–68 in: Dyne, G.R. and Watson, D.W. (eds), *Fauna of Australia. General articles*. Vol. 1A. Australian Government Publishing Service: Canberra.

Reference citations use the following style: Paulin, 1986; Last and Stevens, 1994; Smith et al., 1990.

In taxonomic papers synonymies should be of the form: taxon, author, year, pages, figures. A period and dash must separate taxon and author except in the case of reference to the original description, e.g.

Leontocaris Stebbing, 1905: 98–99.—Barnard, 1950: 699.

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Supplementary information (extended lists of material examined, databases etc.) should be submitted electronically with the original manuscript and will be included with material sent to referees. The Editorial Board encourages use of supplementary information to minimise the cost of printing as long as the requirements of the International Code of Zoological Nomenclature are met in the printed paper.

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Deep-water hydroids (Hydrozoa: Leptolida) from Macquarie Island

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Abstract Watson, J.E. 2003. Deep-water hydroids (Hydrozoa: Leptolida) from Macquarie Island. *Memoirs of Museum Victoria* 60(2): 151–180.

A cruise conducted by RV *Southern Surveyor* between latitudes 53°0′S and 56°17′S and longitudes 158°30′E and 159°25′E sampled 11 sites by dredging at depths ranging from 364 to 1422 m off subantarctic Macquarie Island. Twenty-seven species of hydroids including six new, were identified from the collection. There was no discernible distributional pattern of species with depth. The most diverse hydroid assemblage was recovered from 500–600 m depth and the second richest at 1064 m.

Keywords Hydrozoa, Leptolida, Macquarie Island, hydroids, taxonomy

Introduction

In January 1999 the Australian Commonwealth Science and Industry Research Organisation (CSIRO) undertook a survey of subantarctic areas to the north, south and west of subantarctic Macquarie Island. Cruise SS01/99 by RV *Southern Surveyor* was conducted over a period of three days in the region 53°0′S–56°17′S, 158°30′E–159°25′E. While primarily designed to assess commercial fish stocks the cruise also included benthic sampling to provide a scientific basis for development of a Commonwealth of Australia Marine Protected Area around Macquarie Island (Butler et al., 2000). Sampling of the epifauna was undertaken by benthic sled at 11 sites at depths ranging from 364 to 1422 m (Table 1). Video imaging of the bottom revealed a barren rocky or debris-strewn bed with a sparse epifauna (Butler et al., 2000).

Twenty-seven species of hydroids including six new, and three probably new (but due to insufficient or poorly preserved material unidentifiable) were recorded (Table 2). *Calamphora quadrispinosa* sp. nov. and *Tulpa diverticula* Totton, 1930 were recorded from five stations; *Lafoea tenellula* Allman, 1877 and *Acryptolaria patagonica* El Beshbeeshy, 1991 at four stations; *Eudendrium ?cyathiferum* Jäderholm, 1904, *Tripoma arboreum* Hirohito, 1995 and *Zygophylax sagamiensis* Hirohito, 1983 at three stations. The remaining species were recorded at only one or two stations. No discernible distributional pattern of species occurred with depth, the richest fauna (14 species) coming from stn 44 at a depth of 500–600 m, the second richest haul being from stn 120 at a depth of 1064 m.

The most abundant free-growing species were large colonies of *Eudendrium ?cyathiferum* recorded from depths of

Table 1. CSIRO cruise SS01/99 stations (All material collected by benthic dredge)

Stn	Date	Latitude/Longitude, Start–Finish	Depth (m)
44	19 Jan 1999	56°15.7′S, 158°30.2′E–56°18′S, 158°28.7′E	500–600
46	19 Jan 1999	56°15.7′S, 158°30.2′E–56°18.7′S, 158°25.099′E	600–1300
63	22 Jan 1999	54°40.8′S, 158°38.999′E–54°41.5′S, 158°42.2′E	444
90	26 Jan 1999	54°31.6° S, 158°59.3° E–54°35.5° S, 159°0.8° E	818
94	26 Jan 1999	53°55.8′S, 159°5.5′E–53°55.7′S, 159°4.7′E	453°
96	26 Jan 1999	53°54.7′S, 159°1.901′E –no finish data	1024
97	26 Jan 1999	53°55.9′S, 158°5.9′E–53°54.9′S, 159°2.2′E	364
119	30 Jan 1999	53°38.1′S, 159°9 599′E –53°36.4′S, 159°8.2′E	1046
120	30 Jan 1999	53°38′S, 159°9.5′E–53°36.8′S, 159°10.799′E	1064
122	30 Jan 1999	53°37.2′S, 159°11.299′E–53°34.4′S, 159°17.401′E	1158
130	31 Jan 1999	52 59.4′S, 159°59′E–53°2′S, 159°58.2′E	1422

1046–1158 m, *Tripoma arboreum* at 444–1158 m, *Acryptolaria patagonica* at 453–1422 m and an arborescent species of *Halecium*. Smaller species epizoic on these and other hydroids included *Filellum conopeum* sp. nov. growing on haleciids and acryptolariids; *Tulpa diverticula* abundant on a variety of hydroid hosts, *Calamphora quadrispinosa* sp. nov. abundant on *Symplectoscyphus paulensis* and *Eudendrium*, and *Lafoea tenellula* on *Tulpa diverticula* and *Eudendrium*. The diverse fauna from stn 44 consisted of a tangled mass of hydroids growing on the stem of a dead primnoid gorgonian.

Type and voucher material is lodged in the Tasmanian Museum, Hobart (TM) and Museum Victoria, Melbourne (NMV).

Table 2. Species and their occurrence at stations

Species	SS01/99 Stn No.
Hydractinia sp.	44
Eudendrium ?cyathiferum Jäderholm, 1904	119, 120, 122
Eudendrium deforme Hartlaub 1905	44, 46
Eudendrium macquariensis sp. nov.	44
Eudendrium sp.	44
Tripoma arboreum Hirohito, 1995	63, 97, 122
Lafoea tenellula Allman, 1877	44, 90 119, 120
Lafoea dumosa (Fleming, 1828)	44
Lafoea annulata sp. nov.	44
Filellum conopeum sp. nov.	94, 119, 130
Zygophylax sagamiensis Hirohito, 1983	63
Acryptolaria conferta (Allman, 1877)	44
Acryptolaria patagonica El Beshbeeshy 1991	44, 90, 92, 130
Acryptolaria minuta sp. nov.	133
Halecium ralphae Watson and Vervoort, 2000	119
Halecium tenellum Hincks, 1861	120
Halecium ovatum Totton, 1930	120
Halecium delicatulum Coughtrey, 1876	119, 120, 122
Halecium sp.	90, 122
Calamphora quadrispinosa sp. nov.	44, 46, 94, 120, 130
Staurotheca affinis (Jäderholm, 1904)	44, 122
Symplectoscyphus paulensis Stechow, 1923	94, 120
Symplectoscyphus tuba Totton, 1930	94, 120, 122
Thyroscyphoides sympodialis sp. nov.	44
Gymnangium japonicum Watson and Vervoort, 2001	122
Tulpa diverticula Totton, 1930	44, 90, 94, 119, 120
Campanularia hicksoni Totton, 1930	44

Anthoathecata

Hydractiniidae L. Agassiz, 1862

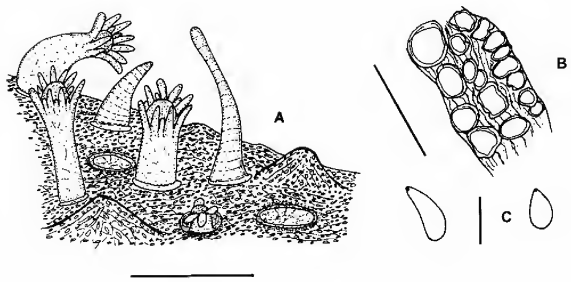
Hydractinia van Beneden, 1841

Hydractinia sp.

Figures 1A–C

Material examined. Stn 44, TM K2768, a small infertile colony on axis of dead primnoid gorgonian, spreading onto *Eudendrium* stem, specimen alcohol preserved.

Description. Hydrorhiza consisting of anastomosing stolons embedded in a fine trabeculate meshwork of perisarc to 1.4 mm thick; meshwork penetrated and in some places externally



Figures 1A–C. *Hydractinia* sp., stn 44. A, part of colony. B, trabeculate meshwork of basal perisarc. C, nematocysts, possibly euryteles, undischarged. Scale bar: A, 1 mm; B, 0.1 mm; C, 10 μm.

covered by coenosarc. Mature gastrozooids columnar, stout, emerging from perisarcal meshwork; hypostome dome-shaped, surrounded by c. 12 stubby, slightly tapering tentacles (preserved material); tentacles often alternately long and short. Tentaculozooids styloid, tapering, very extensible, arising from a broad base in perisarc meshwork. Bases of gastrozooids and tentaculozooids may be surrounded by a collar of coenosarc or erupt from a shallow pit in perisarc. Many short zooids bearing 4 or 5 tentacles just emergent above basal meshwork. No solid spines present but instead, hollow mounds of perisarc common, circular in cross-section and invested by the perisarcal meshwork.

Nematocysts of two sizes present, probably euryteles, none discharged: (i) bean-shaped, 11–12 × 4–5 μm, in body of gastrozooid and in tentaculozooid; (ii) elongate ovoid, 8–10 × 4–5 μm, in tentacles of gastrozooid.

Gonozooids absent.

Colour. Gastrozooids and tentaculozooids white, basal perisarcal meshwork shining golden-yellow.

Remarks. The hydrorhizal meshwork is composed of chitinous strands surrounding subcircular holes which vertically penetrate the meshwork. No structures which could be identified as spines occur, the scattered mounds and peaks being hollow protrusions of the perisarcal meshwork

Apart from Millard (1975) and Schuchert (1996) few authors have adequately described the cnidome of *Hydractinia*. Such knowledge would undoubtedly lead to easier identification of species. In the present formalin-preserved sample the nematocysts are undischarged and cannot be further identified.

Small zooids with four or five tentacles among the larger gastrozooids are probably developing gastrozooids; other unstructured white rings flush with the surface of the hydrorhizal meshwork may be introverted gastrozooids. The finely structured hydrorhizal meshwork investing the hydroid host bears a remarkable resemblance to the ectoderm of *Solanderia*. Despite careful search and examination of sections of perisarc, no gonozooids were found.

Stepanjants (1979) gave a key to the following Antarctic species of *Hydractinia: H. antarctica* Studer, 1879, *H. angusta* Hartlaub, 1904, *H. clavata*, Jäderholm, 1905, *H. parvispina* Hartlaub, 1905, *H. pacifica* Hartlaub, 1905 and *H. vallini* Jäderholm, 1926. The absence of basal spines in the perisarc

considerably narrows the possible matches to known species of *Hydractinia*, including those of the wider concept of *Hydractinia* of Bouillon et al. (1997) and Boero et al. (1998). The present specimen most closely resembles *H. angusta* but in the absence of reproductive structures it cannot be confidently assigned any of these species nor described as new.

Eudendriidae L. Agassiz, 1862

Eudendrium Ehrenberg, 1834

Eudendrium ?cyathiferum Jäderholm

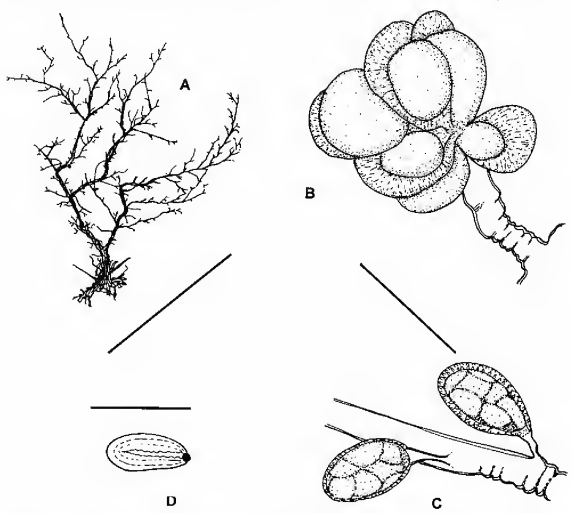
Figures 2A–D

Eudendrium cyathiferum Jäderholm, 1904: 11.—Jäderholm, 1905: 10, pl. 4 figs 1–3.—Bedot, 1925: 184.—Stepanjants, 1979: 18, pl. 1 fig. 13.—Marques et al., 2000: 92, fig. 42.

Material examined. Stn 120, NMV F91307, colony 50 mm high, attached to fragment of calcareous bryozoan, specimen alcohol preserved. Stn 122, TM K2769, four colonies, the largest 90 mm high and 50 mm wide, attached to a dead solitary coral, *Caryophyllia* sp., specimen alcohol preserved.

Description. Colonies arborescent with thick, heavily fascicled main stems up to 3 mm wide at base; hydrorhiza a mass of stolons entwining substrate, becoming erect as polysiphonic tubes of stem. Branching twiggy, in many orders, almost in one plane, polysiphonic tubes running almost to tips of branches but ultimate branches and branchlets (pedicels) monosiphonic, given off from within the mass of tubes. Pedicels short, arising more or less alternately from branches, with up to 10 clear basal corrugations, remainder of pedicel more or less rugose. No hydranths present on pedicels.

Several clusters of female gonophores on colony from stn 122; 6–10 immature gonophores in cluster completely replacing a hydranth, clusters seated on short, corrugated pedicels; gonophore encircled by a large spadix shed as gonophore matures; a single mature gonophore ovoid, borne on a slender peduncle with dish-shaped distal end, gonophore at this stage 0.4 mm long and 0.25 mm wide, enclosed in a distinct transparent pellicle, containing 6–8 developing ova.



Figures 2A–D. *Eudendrium ?cyathiferum.* A, female colony, stn 122. B, cluster of immature female gonophores on colony. C, mature female gonophores with ova from same colony. D, undischarged eurytele from coenosarc of branch. Scale bar: A, 50 mm; B, C, 0.5 mm; D, 10 μm.

No nematocysts seen on gonophores; a few undischarged euryteles present in coenosarc of stems; capsule small, droplet shaped, 8 × 4.5 μm.

Colour. Fascicled stems and branches shining brown, fading to yellowish on monosiphonic branches; gonophores were probably creamy-pink.

Distribution. Previously recorded from South Georgia (Jäderholm, 1905; Stepanjants, 1979) but now known to have a wider distribution in deep subantarctic and Patagonian waters (A. Marques, pers. comm.).

Remarks. There are two differences between the present specimen and available published and unpublished descriptions of *E. cyathiferum*. These are: (i) the length of the peduncle of the nearly mature gonophore; and (ii) the presence of only one size of eurytele in the cnidome.

Three species of *Eudendrium* with pedunculate (i.e. secondary pedicellate) female gonophores are known: *E. cyathiferum, E. vervoorti* Marques and Migotto, 1998 and *E. glomeratum* Picard, 1951 (see Marques et al., 2000). *E. glomeratum* was rejected as it is a temperate to tropical species (Watson, 1999), *E. vervoorti* is discounted because of the small size of the colony and the fact that the developing female gonophore lacks an encircling spadix. Although the "golf-tee" peduncle supporting the nearly mature female gonophore of the present specimen is typical of *E. cyathiferum* it is, however, somewhat longer and slenderer than that shown in a photomicrograph of the type specimen (Marques et al., 2000).

The cnidome of the holotype specimen of *E. cyathiferum* contains two size classes of euryteles, the smaller associated with the hydrocaulus and the larger with the gonophore (A. Marques, pers. comm.). In view of the limited amount of present material available for study it could not be ascertained if large nematocysts are always absent from the gonophore. The few nematocysts in the coenosarc are similar in size to those in the hydrocaulus of the holotype.

For the above reasons, together with the fact that the colonies are smaller than previously reported for *E. cyathiferum*, the present specimens are doubtfully referred to that species.

Eudendrium deforme Hartlaub

Figures 3A–D

Eudendrium deforme Hartlaub, 1905: 508, 514, 552, figs B', C'.—Bedot, 1925: 184.

Material examined. Stn 44, NMV F91308, many sparsely fertile colonies on dead stem of a primnoid gorgonian, colonies intergrown and entangled with *Tulpa diverticula*, sertularian and *Eudendrium* colonies, specimen alcohol-preserved. Stn 46, TM K2770, many colonies on dead stem of primnoid gorgonian, specimen alcohol-preserved.

Description. Colonies comprising many tangled stems up to 70 mm long and 0.3–0.4 mm diameter arising from a hydrorhiza entwining stem of host. Stems more or less straight to curved, monophonic, with 5–10 strong basal annulations and groups of annulations at intervals along stems.

Stems sparsely, alternately, but irregularly branched, more or less in one plane, occasionally secondary branching occurs; branchlets (pedicels) more or less alternate, spaced well apart, short to moderately long, beginning with up to 10 deep annulations; stems sometimes annulated throughout; perisarc otherwise smooth. A few hydranths in poor condition remain on colonies; hydranth large, with c. 24 tentacles. Perisarc of lower stems thick and smooth, thinning distally along smaller branches and pedicels.

Nematocysts all undischarged euryteles of one size: small, droplet-shaped, a few in coenosarc of stems and tentacles of hydranth, capsule 10 × 6 μm.

Male gonophores present on several colonies; clustered on short, smooth to corrugated pedicels near base of stems; up to 5 in a beaded chain, apical gonophore single, gonophores below paired; tentacles of hydranth partially resorbed and reduced in number, hypostome intact.

Colour. Lower stem shining in dark brown, fading distally to pale yellowish; gonophores white.

Distribution. Calbuco, Chile; Mar del Plata, Argentina (Hartlaub, 1905).

Remarks. Due to entanglement of the stems it is difficult to decide if one or many colonies are present. The few hydranths are in very poor condition, due either to damage during collection or senescence of the colony. The species is distinguished by its strictly monosiphonic, shining brown stems and paired chain of immature gonophores.

Although Hartlaub's description of the species is brief I have no doubt that the present specimens are referrable to *Eudendrium deforme*. Like much of the present material, Hartlaub's specimens apparently comprised bare stems lacking hydranths or reproductive structures. The thin brown stems, as described and figured by Hartlaub are characteristic. The species has not been recorded since its first description.

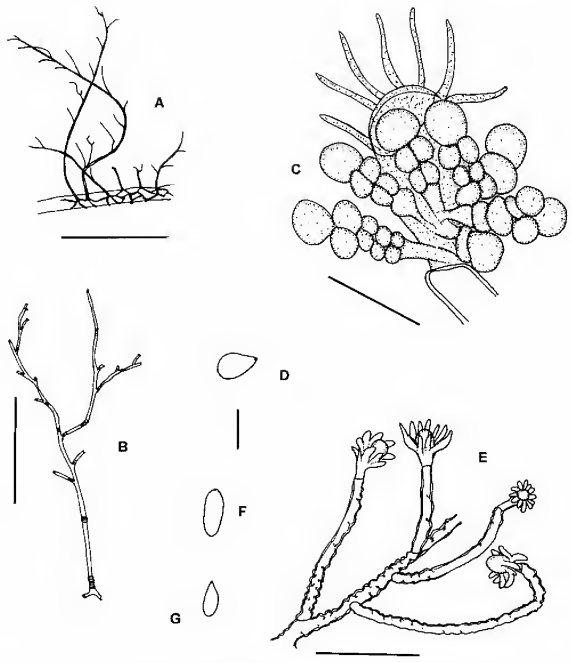
Eudendrium macquariensis sp. nov.

Figures 3E–G

Material examined. Stn 44, NMV F91309, holotype, abundant infertile colonies on stems and branches of other species of *Eudendrium*, specimen alcohol-preserved.

Description (of holotype). Stolons creeping over stems and branches of hydroid host, stems numerous, to 7 mm long; stems (pedicels) and stolons morphologically identical and 0.1 mm diameter. Stems monosiphonic, unbranched, straggling, straight or flexed, perisarc of stolons and pedicels distinctly to weakly rugose throughout. Hydranths very small, distal on pedicel, hypostome prominent, dome-shaped, surrounded by 10–14 tentacles. Perisarc of stolon and stems firm and of same thickness throughout.

Nematocysts of two kinds present, both undischarged: (i) small droplet-shaped euryteles, capsule 9–10 × 4–5 μm, very abundant in tentacles; (ii) bean-shaped capsule 9 × 4 μm, rare, site unknown.



Figures 3A–G. A, *Eudendrium deforme*. A, part of colony on dead branch of primnoid gorgonian, stn 46. B, single stem. C, cluster of male gonophores with paired immature gonophores and partially resorbed tentaclesof hydranth. D, undischarged nematocyst, probably eurytele from coenosarc of stem. E–G, *Eudendrium macquariensis* sp. nov., stn 44. E, stems from holotype colony on *Eudendrium deforme*. F, undischarged nematocyst from tentacles. G, undischarged nematocyst, site unknown. Scale bar: A, 25 mm; B, 10 mm; C, 0.5 mm; E, 1 mm; F, G, 10 μm.

Colour. Stolons white, stems clear pale yellowish, hydranths white.

Etymology. The specific name refers to the type locality.

Remarks. The colonies of *Eudendrium macquariensis* so thickly invest the stems and tips of branches of the hydroid host that when first examined they seemed to be part of the host colony. Closer examination revealed white stolons of *E. macquariensis* running along the brown perisarc of the host. The thick aggregations on the tips of the host permits this tiny species to occupy an exceedingly crowded microhabitat. As both stolons and stems are morphologically identical it is difficult to judge at what stage the stolon becomes an erect stem.

The species is unusual in that the straggling stolon-stems are almost entirely rugose. The rugosity is usually most conspicuous in the proximal pedicel region, as usual in *Eudendrium*. Although the hypostome is dome-shaped rather than annular, this may be an artefact of preservation; it is, however, quite constant throughout the material. If the dome-shape is diagnostic it sets *E. macquariensis* somewhat apart from other known species of *Eudendrium*.

Eudendrium sp.

Figures 4A–C

Material examined. Stn 44, NMV F91310, many sparsely fertile colonies intergrown with *Eudendrium deforme* on a dead branch of primnoid gorgonian, specimen alcohol-preserved.

Description. Colonies short, arborescent and shrubby, the largest 20 mm high and 20 mm wide. Main stem and branches strongly fascicled, branching irregular in many planes, polysiphonic tubes running up branches to distal region, ultimate branchlets (pedicels) monosiphonic, 0.1 mm in diameter, base of pedicel with up to 20 annulations, perisarc thereafter smooth to faintly corrugated.

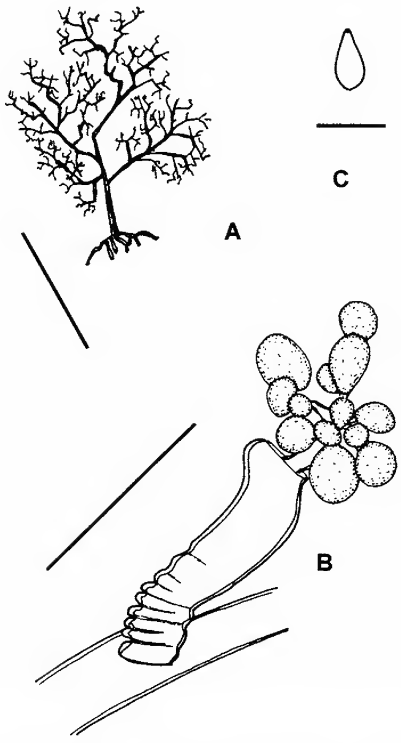
Few hydranths remain, all in poor condition; small, with 12–14 moderately long tentacles.

Nematocysts small eurytheles in tentacles and coenosarc, droplet-shaped, capsule 8.5 × 4.5 μm, undischarged.

Male gonophores borne on a short, basally annulated pedicel; a small cluster in series of 3 or 4 surrounding a completely resorbed hydranth.

Colour. Lower stems pale honey-brown, fading to almost transparent on ultimate branches; hydranths white.

Remarks. While the small, shrubby colony with male gonophores surrounding a completely atrophied hydranth reduces the possible matches with known species, in the absence of hydranths and female gonophores and details of the cnidome, identification is not taken further.



Figures 4A–C. *Eudendrium* spec., stn 44. A, colony on dead branch of primnoid gorgonian, stn 44. B, cluster of male gonophores. C, undischarged nematocyst, probably eurytele; in tentacles and coernosarc. Scale bar: A, 20 mm; B, 0.5 mm; C, 10 μm.

Leptothecata

Campanulinidae Hincks, 1868

Tripoma Hirohito, 1995

Tripoma arboreum Hirohito

Figures 5A–C

Tripoma arboreum Hirohito, 1995: 98, figs 28a–e, pl. 6, fig. A.—Watson and Vervoort, 2000: 249, figs 1A–D, 2A–J.—Watson and Vervoort, 2001: 156, fig. 3a–b.

Material examined. Stn 63, NMV F91311, several infertile colonies, the tallest 40 mm high on a primnoid gorgonian, specimen alcohol preserved. Stn 97, TM K2771, specimens alcohol-preserved. NMV F91332, Stn 97, malinol-mounted microslide.

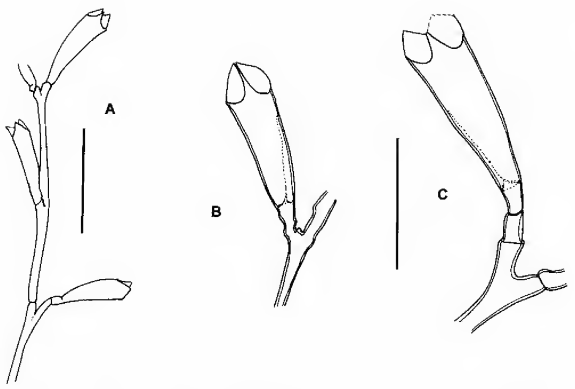
Description. Colonies erect, branched, the tallest 75 mm high. Hydrorhiza reptant on stem of host, tubular, undulating, sometimes contorted. Erect stems arising from hydrorhiza, some hydrothecae arising directly from stolon. Most stems polysiphonic, several younger stems monosiphonic and unbranched, older stems with increasingly polysiphonic. Stem internodes variable in length, cylindrical, smooth, nodes usually distinct, transverse to slightly oblique, marked by a constriction in perisarc. Apophyses alternate, long, distal on internode, directed upwards at c. 45° to internodal axis, often shifted slightly around stem, distal node of apophysis transverse, sometimes extended into two or three segments, each with deep transverse node.

Hydrothecae inverted conical, long, slender, slightly asymmetrical in section, arising from stem apophysis, usually a well to poorly marked internode between apophysial segment and hydrotheca; adcauline wall weakly convex, abcauline wall straight to weakly concave, a ring of tiny punctae near base of hydrotheca, a band of remnant tissue extending diagonally upwards into hydrotheca from desmocyte ring. Margin with 2 long, sharp triangular cusps separated by deeply scalloped embayments, demarcation between margin and hydrothecal body faint, operculum splits into at least 4 thin flaps. Perisarc of hydrotheca delicate, thinning markedly to margin.

Colour. Colony pale honey-yellow, distal parts and hydrothecae almost colourless.

Measurements (μm)

Hydrorhiza	
diameter	80–160
Stem	
length of internode	960–1200
width at node	59–86
diameter at node	72–88
adcauline length of proximal apophysis	52–100
diameter at proximal apophysial node	64–80
length of apophysis including extensions	80–200
Hydrotheca	
length including pedicel	770–941
length, base to apex of cusps	784–848
width of margin across base of cusps	200–264
depth of opercular embayment	136–160



Figures 5A–C. *Tripoma arboreum*, stn 97. A, part of stem. B, hydrotheca with closed operculum. C, hydrotheca with operculum open. Scale bar: A, 1 mm; B, C, 0.5 mm.

Distribution. Japan, Tasman Sea and Bass Strait, Australia (Watson and Vervoort, 2001).

Remarks. The material conforms to the descriptions of colonies of *Tripoma arboreum* given by Watson and Vervoort (2000, 2001). A feature not noted in previous descriptions is a line of very small punctae in some hydrothecae a short distance above the distalmost apophysial node, passing transversely to obliquely across the hydrotheca and then continuing upward as a line of granules, gradually merging with the hydrothecal wall below the margin. Tissue remnants attached to the granules in some hydrothecae suggest they provide support for the hydranth.

Lafoeidae A. Agassiz, 1865

Lafoea Lamouroux, 1821

Lafoea tenellula Allman

Figures 6A–C

Lafoea tenellula Allman, 1877: 12, pl. 8 figs 3, 4.—Ritchie, 1911: 820, pl. 88 fig. 5.—Stechow, 1913: 110.—Stechow, 1923a: 10.—Stechow, 1923b: 143.—Stechow, 1925: 453, fig. 23.—Leloup, 1940: 14.—Fraser, 1943: 90.—Fraser, 1944: 227, pl. 47 fig. 211.—Fraser, 1948: 232.—Deevey, 1954: 646.—Riedl, 1959: 646.—Yamada, 1959: 49.—Vervoort, 1968: 101.—Millard, 1973: 28.—Hirohito, 1995: 128, figs 36d–f.

Material examined. Stn 44, NMV F91312, specimen alcohol-preserved, NMV F91339, malinol mounted microslide of coppinia; fertile colonies on *Eudendrium* and on primnoid gorgonian. Stn 90, NMV F91333, malinol-mounted microslide, fragment detached from substrate. Stn 119, TM K2772, specimen alcohol-preserved, NMV F91334, malinol-mounted microslide, colony on *Eudendrium*. Stn 120, NMV F91313, sparingly fertile colony on *Tulpa diverticula* and *Eudendrium*, specimen alcohol-preserved.

Description. Hydrorhiza reptant on host hydroids, stolons crumpled, colony predominantly stolonal but sometimes a short length of stolon becoming free as an erect monosiphonic stem.

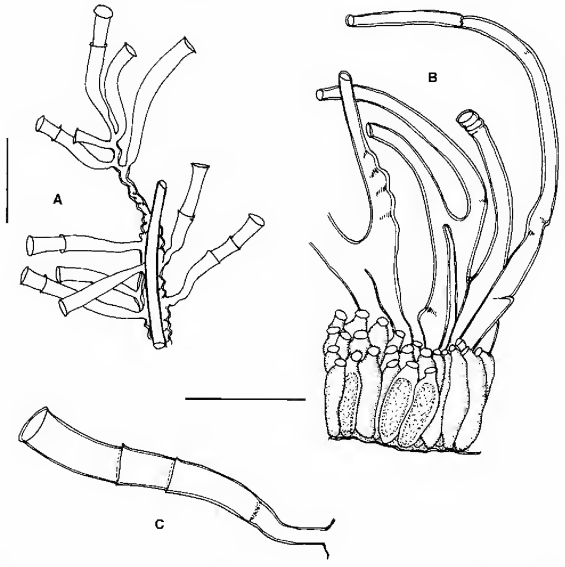
Hydrothecae given off irregularly in all directions from hydrorhiza; hydrothecae long, elongate conical, radially symmetrical, straight to faintly sinuous, no true pedicel but a tubular narrowing of hydrotheca. A faint transverse to slightly oblique ring of scattered punctae sometimes present marking distal junction of pseudopedicel with hydrotheca, sometimes a faint constriction in perisarc of hydrotheca at desmocyte ring. Margin transverse to hydrothecal axis, circular, rim weakly everted with up to seven, usually widely spaced, regenerations. Persiarc of hydrotheca moderately thick near base, thinning distally to margin. Hydranths not well preserved, deeply contracted into hydrothecae, but probably with eight to 10 tentacles.

Coppinia comprising a tightly packed circle of gonothecae seated on a thin, dish-shaped basal plate adherent to stem of hydroid host; protective nematophore tubules scattered in irregular groups around and throughout coppinia. Gonothecae small, crowded, flask-shaped, bases rounded, widening from base to shoulder, surmounted by a short tubular neck with transverse, slightly everted circular orifice; perisarc of gonothecae rather thin. Ovoid gonophores (or planulae) present in some gonothecae but too degenerate for description. Protective tubules varying in length from short to very long, tubular in section, single or bifid, some completely or partially conjoined proximally, straight or curved, narrowing from base to apex; terminal orifice circular; perisarc thick, usually smooth; some undulated; others showing scars from interruptions to growth.

Colour. Colonies and coppiniae transparent colourless; gonophores pale creamy white.

Measurements (μm)

Hydrorhiza	
diameter	68–88
Hydrotheca	
length of unregenerated hydrotheca	360–500



Figures 6A–C. *Lafoea tenellula*, stn 97. A, stolonal colony on branch of *Eudendrium*, hydrorhiza produced into free stolon. B, regenerated hydrotheca. C, longitudinal section through coppinia. Scale bar: A, 1 mm; B, C, 0.5 mm.

length of regenerated hydrotheca	1060–1440
width at puncta ring	76–112
diameter at margin	168–240
Coppinia	
overall length of gonotheca	320–440
maximum width of gonotheca	80–112
diameter of gonothecal orifice	48–60
length of nematophorous tubules	500–1700
width of tubule at base	96–104
diameter of orifice of tubule	48–56

Distribution. Australian east coast (Ritchie, 1911), California (Fraser, 1948), Carribean, West Indies (Vervoort, 1968), Japan (Hirohito, 1995). The geographical and bathymetric distribution of *L. tenellula* ranges from moderately deep tropical and temperate waters to deep subantarctic waters (this collection).

Remarks. The hydrothecae on younger parts of the colonies are less crowded than those on older regions. The hydranths are deeply contracted into the hydrothecae and the tentacles of reasonably well preserved ones appear to be enclosed in a sheath of tissue.

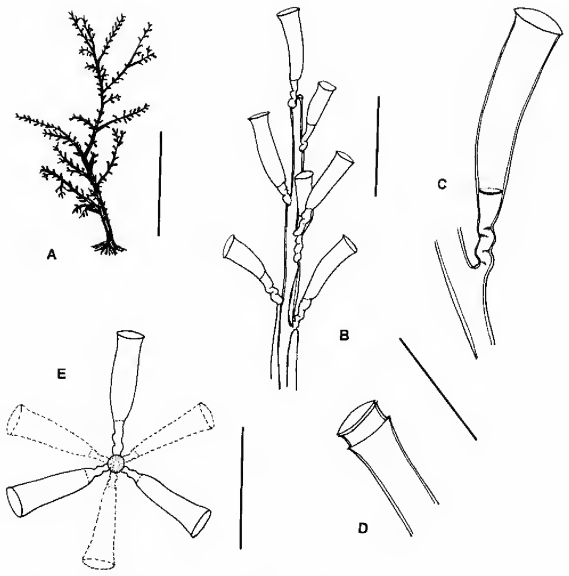
The present material generally matches the description, dimensions and figure of *Lafoea tenellula* given by Stechow (1925) for specimens from Madeira and the Canary Islands but conforms less well with the figure of hydrothecae given by Hirohito (1995) for the species from Japan.

Three coppiniae were found among colonies in the collection; one was attached to the stem of *Eudendrium* from Stn 119 and the others to a primnoid gorgonian stem (Stn 44). Because of intergrowth of the material with hydrorhizae of several other hydroid species the coppiniae are ascribed with some hesitation to *L. tenellula*, the gonosome of which is not known. Vervoort (1966) renamed *L. tenellula* recorded by Ritchie (1911) from off the Australian temperate east coast *Hebella ritchei*. I have examined Ritchie's material and other Australian east coast specimens held in the Australian Museum, Sydney; as they are identical with the present specimen, Ritchie's identification of *L. tenellula* is correct.

Lafoea dumosa (Fleming)

Figures 7A–E

Sertularia dumosa Fleming, 1820: 83 (nomen nudum).
Campanularia dumosa.— Fleming, 1828: 548–549.
Lafoea dumosa.—Hutton, 1904: 319.—Fraser, 1911: 51.—Billard, 1912: 464.—Stechow, 1912: 357.—Stechow, 1913: 30.—Fraser, 1914: 86.—Fraser, 1918: 333, 354.—Stechow, 1919: 80, fig. A1.—Fraser, 1921: 73.—Fraser, 1922: 5.—Stechow, 1923a: 10.—Billard, 1927: 331.—Fraser, 1927: 326.—Totton, 1930: 158, fig. 14.—Billard, 1931: 245.—Leloup, 1934: 8.—Fraser, 1935: 144.—Kramp, 1935: 123, figs. 52a, 53.—Fraser, 1937: 119–120, pl. 25 fig. 137.—Fraser, 1938: 110.—Fraser, 1939: 160.—Leloup, 1940: 14.—Vervoort, 1942: 285.—Fraser, 1944: 221, pl. 45 fig. 205, pl. 46 fig. 205.—Fraser, 1948: 229.—Teissier, 1950: 17.—Deevey, 1954: 270.—Hamond, 1957: 295, 307.—Ralph, 1958: 310.—Riedl, 1959: 646.—Yamada, 1959: 50.—Leloup, 1960: 221.—Naumov, 1960: 276, fig. 165.—Rees and Thursfield, 1965: 79.—Teissier, 1965: 19.—Redier, 1967: 389.—Vervoort, 1968: 100.—Calder, 1970: 1524, pl. 5 fig. 3.—Christiansen, 1972: 296.—Calder, 1975: 299, fig. 3D.—Cornelius, 1975: 385, fig. 4.—Millard, 1975: 185.—Millard, 1977a: 15.—Millard, 1978: 195.—



Figures 7A–E. *Lafoea dumosa*, stn 44. A, colony. B, part of branch. C, hydrotheca with typically twisted pedicel and diaphragm. D, hydrotheca with replicated margin. E, radial arrangement of hydrothecae around stem. Scale bar: A, 10 mm; B, E, 1 mm; C, D, 0.5 mm.

García Corrales et al., 1979: 19, fig. 8.—Millard, 1980: 131.—Stepanjants, 1980: 116.—Hirohito, 1983: 6, 21.—Stepanjants, 1985: 127, 131.—Antsulevich, 1987: 49, fig. 11B.—Rees and Vervoort, 1987: 40, figs 7–8.—Cornelius, 1988: 76.—Llobet et al., 1988: 38, fig. 4E.—Gili, Murillo and Ros, 1989: 23.—Gili, Vervoort and Pagès, 1989: 73, fig. 3B.—Cornelius and Ryland, 1990: 135, fig. 4.13.—El Beshbeeshy, 1991: 84, fig. 20.—Peña Cantero, 1991: 70, pl. 5 figs a–d.—Calder, 1992: 1080.—Cornelius, 1992: 254, 257.—Ramil and Vervoort, 1992: 55.—Boero and Bouillon, 1993: 263.—Branch and Williams, 1993: 10.—Cornelius, 1995: 261, fig. 60.—Hirohito, 1995: 126, figs 36a–c, pl. 8 fig. A.—Medel and López-González, 1996: 198.—Peña Cantero and García Carrascosa, 1995: 23, figs 4A–D.—Stepanjants et al, 1996: 7.—Peña Cantero and García Carrascosa, 1999: 212.—Schuchert, 2000: 413.—Schuchert, 2001: 67, figs 54 A–D, 55, 56.
Lafoea ?dumosa.—Ralph, 1958: 310.
Campanularia fruticosa M. Sars, 1850: 131, 138.
Campanularia gracillima Alder, 1856: 361, pl. 14 figs 5, 6.
Lafoea gracillima.—Ralph, 1958: 310, figs 1y, 2a–c.
Lafoea capillaris G.O. Sars, 1874: 115, pl. 4 figs 4, 5.
Lafoea elegantula Broch, 1903: 5–6, pl. 1, figs 5, 6, pl. 2, figs 7–9.

Material examined. Stn 44, TM K2773, NMV F91314, specimen alcohol-preserved. NMV F91340, malinol-mounted microslide from colony, abundant infertile colonies on primnoid gorgonian.

Description. Colonies arborescent, delicate and rather lax, the largest 25 mm high and 15 mm wide across the branches, stem 0.8 mm wide above base; smallest colonies 3–5 mm high. Hydrorhiza thread-like tubular stolons reptant on substrate; stolons bunched at base of complex colonies. Smallest stems monosiphonic, taller colonies with 2 or more polysiphonic tubes running up stem and along branches. Colonies branched

at acute upward angles but in no particular order around stem; branches fascicled proximally, becoming monosiphonic distally, perisarc smooth without nodes. In proximal stem region of larger colonies tubes rather twisted, gradually becoming more or less parallel.

Hydrothecae given off from stem and branches, on monosiphonic branches (hydrocladia) arranged in whorls of three at an angle of c. 120° around hydrocladium, but occasionally an opposite pair; each hydrotheca well separated from its neighbour; in polysiphonic branches where hydrothecae given off from outer tubes of stem or branch this verticil arrangement obscured. Hydrothecal pedicel long, directed at an acute upward angle to hydrocladium, tubular, expanding distally to merge smoothly into hydrotheca, pedicel undulated with to 1–4 bends; a thin transverse line of punctae marking junction of hydrotheca with pedicel, a small annular internal ledge in hydrothecal wall at puncta line. Hydrothecae long, narrowly conical, widening smoothly to margin; body typically asymmetrically bent, adcauline side weakly convex in proximal third, then becoming almost straight or faintly sinuous to margin; abcauline side straight to weakly concave; both walls expanding a little below margin. Margin of hydrotheca circular, perceptibly everted but with no outrolling of rim; some hydrothecae with two or three marginal replications, basalmost replication typically at some distance below margin. Most hydrotheca contain remnants of hydranths with c. 12 tentacles.

Perisarc thickest on lower stem and branches, thinning distally along branches, hydrothecae very thin and smooth.

Colour. Colonies pale yellowish in lower regions, becoming translucent distally. Hydrothecae transparent, shining.

Measurements (μm)

Hydrorhiza	
width of stolon	88–120
Branch	
diameter of monosiphonic part	112–136
length from axil to first hydrotheca	680–720
Hydrotheca	
distance between successive hydrothecae on hydrocladium	240–464
length of pedicel to puncta line	240–280
diameter of pedicel	80–88
diameter at puncta line	96–112
length, puncta line to margin (including replications)	600–664
diameter at margin	176–232

Distribution. Near-cosmopolitan, in Atlantic, Pacific and Indian Oceans, Arctic and Antarctic, depth range from the sublittoral zone to deep sea (Cornelius, 1995; Schuchert, 2001).

Remarks. The hydrothecal pedicels are bent rather than twisted or smoothly annulated with up to 4 kinks; the perisarc is smooth throughout. Most colonies are fascicled, only the very youngest and shortest being monosiphonic. Single hydrothecae are abundant on the hydrorhiza between complex stems. The colonies are quite lax and unable to support their weight out of fluid.

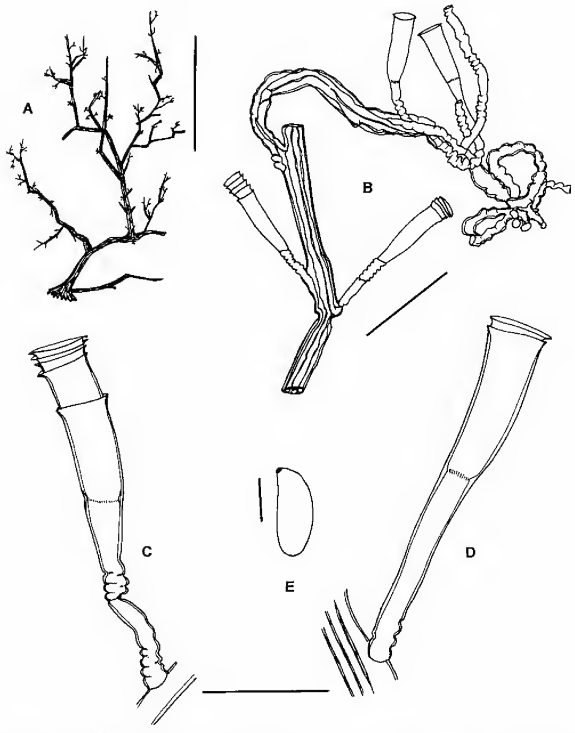
The present material conforms in most respects with earlier descriptions of *Lafoea dumosa*. It does, however, differ somewhat from most descriptions in having an almost invariable triseriate arrangement of the hydrothecae on monosiphonic hydrocladia, this condition usually being obscured in polysiphonic stems and branches, rather than the incipiently triseriate or multiseriate arrangement described by some authors.

Lafoea annulata sp. nov.

Figures 8A–E

Material examined. Stn 44, NMV F91315, holotype, specimen alcohol-preserved, NMV F91341 malinol-mounted microslide from holotype colony; infertile colony on a fragment of primnoid gorgonian, hydrorhiza intergrown with those of other hydroids.

Description (of holotype). Colony 70 mm high and 40 mm wide; hydrorhiza a broken tangled mass of tubular stolons coalescing to form polysiphonic tubes of stem; colony branched almost from base in disorderly flabellate fashion, base of stem and lowest branch 1 mm thick, both heavily fascicled, polysiphonic tubes almost linear, sometimes a little twisted in lower stem region then running up branches; distal region of some branches with 2 or more tubes, a few branches monosiphonic. Branches bent at various angles, becoming more or less straight distally; walls of ultimate branches smooth without nodes. Apical stolonisation occurring on several branches where a tube becomes free of branch, walls of free tubes contorted and undulated, sometimes rejoining branch.



Figures 8A–E. *Lafoea annulata* sp. nov., stn 44. A, colony. B, distal stolonisation at end of branch. C, hydrotheca with twisted and partially annulated pedicel. D, hydrotheca with almost smooth pedicel. E, undischarged nematocyst from coenosarc of branch. Scale bar: A, 25 mm; B, 1 mm; C, D, 0.5 mm; E, 20 μm.

Hydrothecae given off without apophyses from monosiphonic branches or from peripheral tubes of polysiphonic branches; hydrothecae in opposite pairs or in groups of three, one arising from each tube of branch, if three, the third arising close to opposite pair, forming an incipient whorl of 3, groups well separated at variable distances along branch. Hydrothecal pedicels tubular, length variable but mostly long, straight to bent, widening distally and merging smoothly into base of hydrotheca below puncta line; pedicels usually deeply annulated to almost smooth, frequently one side more deeply annulated than other.

Hydrothecae rather fragile, long, tubular, slightly asymmetrically bent with one wall slightly convex in basal third, opposite wall weakly concave to straight; diaphragm very thin, transverse to slightly oblique, saucer-shaped with central hydropore marked by an indefinite double ring of small scattered punctae; a slight thickening of hydrothecal wall at puncta line. Margin of hydrotheca circular, transverse to hydrothecal axis, rim smooth, noticeably everted, many hydrothecae with up to 5 everted marginal replications, usually well separated, some well below rim.

Perisarc in polysiphonic stem region and branches quite thick, thinning in monosiphonic parts; in branches with fewer tubes, perisarc of youngest tube markedly thinner than others; perisarc of hydrothecae thin, transparent and shining. Hydranths too poorly preserved for description; remnants emerging from many hydrothecae as a long strand of tissue.

Nematocysts large, bean-shaped, probably isorhizas, 21–22 × 8.5–9 µm, none discharged, but containing a long, probably isometric, closely coiled tubule; abundant in coenosarc of polysiphonic tubes of branches.

Colour. Colony translucent pale honey-yellow, monosiphonic branches and hydrothecae almost colourless.

Measurements (µm)

Branch	
diameter of monosiphonic branch	56–88
distance between groups of pedicels	900–2000
length of pedicel to puncta line	1720–4000
proximal diameter of pedicel	80–144
Hydrotheca	
diameter at puncta line	128–160
length, puncta line to margin (including regenerations)	520–704
diameter of margin (including eversion)	200–240

Remarks. An empty conical structure at the broken distal end of a branch may be a damaged gonotheca; the structure is transparent, adpressed to the branch with the wider end facing distally and is overgrown by several polysiphonic tubes; it could be an empty corophiid tube. The diaphragm at the puncta line of the hydrotheca may have a downwardly directed hydropore but because of its delicacy the actual structure could not be ascertained. The free stolons at the ends of several branches seem to have developed from hydrothecal pedicels which have reverted to polysiphonic tubes, growth then proceeding onward without development of a hydrotheca. The thin strands of tissue issuing from many hydrothecae may be collapsed protective sheaths of hydranths. Several hydrothecae have remnants of tissue adhering to the rim which could easily be mistaken for opercular fragments.

Similar species considered were *Lafoea fruticosa* (M. Sars, 1850), *L. gracillima* Alder, 1856, *L. capillaris* G. O. Sars, 1874, *L. elegantula* (Broch, 1903), *L. dumosa* Fleming, 1828 and *L. benthophila* Ritchie, 1909. While *L. annulata* has a hydrotheca with everted margin similar to *L. benthophila* that species has an upwardly directed pedicel so that the hydrothecae are held close to the branch. Similarly to *L. annulata*, hydrothecae of *L. dumosa* from western Europe are arranged in groups of two or three (Cornelius, 1995) but lack an everted margin. Vervoort (1972a) described the range of variation of South Atlantic *L. fruticosa* from latitudes 42° to 60° S. However, it is much smaller in critical dimensions of hydrotheca and pedicel and the hydrothecae have less everted margins than those of *L. annulata*. A small colony from the Ross Sea recognised as *L. gracillima* by Totton, 1930 approaches the dimensions of the present specimen but his figures do not show the annulated pedicels characteristic of *L. annulata*.

Filellum Hincks, 1868

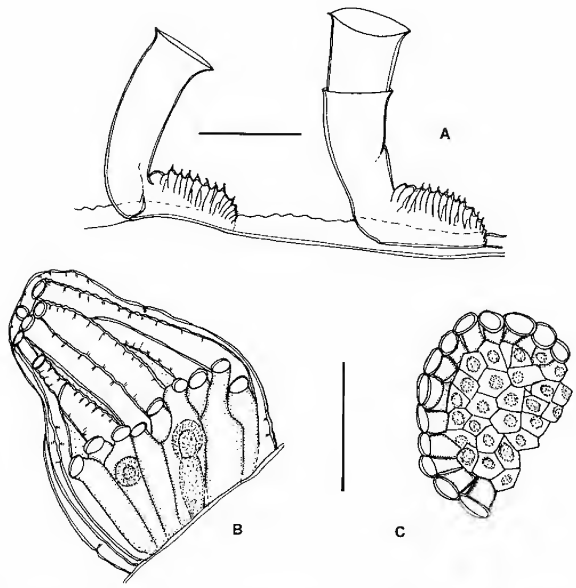
Filellum conopeum sp. nov.

Figures 9A–C

Filellum sp.—Watson and Vervoort, 2001: 161, figs 6a, b.

Material examined. Stn 94, NMV F91342, holotype, malinol-mounted microslide, sparse fertile colony on stem of *Acryptolaria patagonica*.

Description (of holotype). Hydrothecae stolonal, arising from a tunnel-shaped stolon with flattened base, wall rugose, perisarc thin. Proximal quarter to one third of hydrotheca adnate to



Figures 9A–C. *Filellum conopeum* sp. nov., stn 94. A, hydrotheca with ridged and frilled basal perisarc. B, lateral section through coppinia showing gonothecae and protective tubes. C, transverse section through coppinia. Scale bar: A, 0.2 mm; B, 0.5 mm.

stolon, dorsal abcauline wall furrowed by many close, sharp-edged ridges with minute ragged frill of perisarc; ridges fading on adnate wall. Adnate wall becoming free at a sharp upward bend, free part cylindrical or weakly expanding from bend to margin, free part straight to broadly curved, walls smooth, occasionally with several regenerations. Margin circular, transverse, with smooth, distinctly everted rim. Perisarc of walls fairly thick, thinning distally. Hydranth with c. 12 tentacles and clavate hypostome.

Coppinia bud-shaped, c. 1 mm wide and 1 mm high, comprising many tightly packed gonothecae enclosed within a cone of protective nematophorous tubules. Gonotheca flask-shaped (lateral view), base rounded, body expanding a little from base to shoulder then narrowing into a short straight or slightly curved neck tapering to a circular aperture; in transverse view gonothecae polygonal. Nematophorous tubules similar in length, not forked, conjoined just above gonothecae then becoming free, most narrowing distally and inwardly curved to meet above gonotheca; terminal orifice circular. Perisarc of gonothecae and tubes moderately thick; perisarc of tubes somewhat roughened. Planulae enclosed in gonothecae small, spherical.

Colour. Colonies colourless, planulae creamy pink.

Measurements (μm)

Hydrorhiza	
width	40
Hydrotheca	
dorsal length of adnate part	180–240
depth of adnate part	92–116
length of free part	320–420
width of free part at bend	88–128
diameter at margin	140–168
Coppinia	
diameter of nematophorous tubules	64–120
length of gonotheca	320–440
maximum width of gonotheca	128–160
diameter of orifice	64–80
diameter of planula	80–120

Etymology. Named for the cone of tubes protecting the gonothecae.

Remarks. Epizoic colonies of *Filellum conopeum* occur sparsely on the stem of *Acryptolaria*. The thin ragged perisarcal frill surmounting the abcauline ridges of the hydrotheca, together with the bud-shaped coppinia are characteristic.

The trophosome of *F. conopeum* resembles that of *F. serratum*, however, the coppinia of that species as described and figured by Peña Cantero et al. (1998) is quite different, the gonothecae being protected by a canopy of apically divided tubes, some of which originate from within the gonothecal mass. Watson and Vervoort (2001) reported a species of *Filellum* from the deep-water seamounts south-east of Tasmania, Australia, but as their material was infertile and dimensions somewhat greater than those of *F. serratum* (Clarke, 1879) (the only other known species with a wrinkled abcauline wall), they hesitated to identify it with that species. While the hydrothecae of *F. conopeum* are somewhat smaller than those of the Tasmanian specimens I consider the two are conspecific.

Zygophylax Quelch, 1885

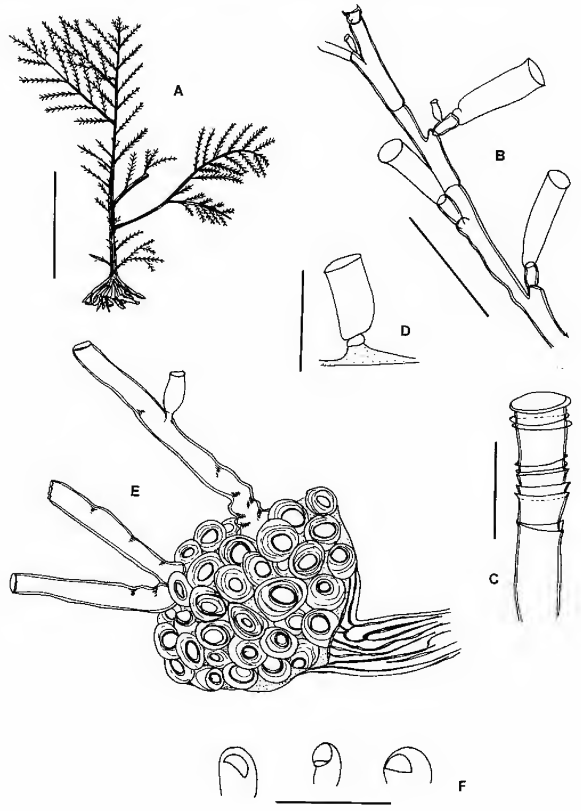
Zygophylax sagamiensis Hirohito

Figures 10A–F

Zygophylax sagamiensis Hirohito, 1983: 30, fig. 11.—Rees and Vervoort, 1987: 85.—Hirohito, 1995: 144, figs 44a–e, pl. 9 fig. C.

Material examined. Stn 44,TM K2775, infertile colony fragment 10 mm high, specimen alcohol-preserved. Stn 63, TM K2774, specimen alcohol-preserved, NMV F91335, malinol mounted microslide from fertile colony fragment 10 mm high on primnoid gorgonian stem. Stn 122, NMV F91316, specimen alcohol-preserved, NMV F91336 malinol-mounted microslide, complete branched colony 60 mm high and 50 mm wide, detached from substrate.

Description. Hydrorhiza a mat of stolons running along axis of gorgonian, bunching together at base of colony then passing upwards to become fascicular tubes of stem. Polysiphonic stems stiff, sparingly subalternately branched, primary branches widely spaced, occasionally secondary subdichotomous branching, one or two polysiphonic tubes running halfway to two thirds along branch or hydrocladium; branch



Figures 10A–F. *Zygophylax sagamiensis*, stn 63. A, colony. B, distal part of branch. C, hydrotheca with multiple marginal replications. D, pedicellate nematotheca on hydrorhiza. E, coppinia. F, hooded gonothecae from coppinia. Scale bar: A, 25 mm; B, 0.5 mm; C, 0.2 mm; D, 0.1 mm; E, F, 0.25 mm.

and hydrocladia thereafter monosiphonic; a hydrotheca in axil of each branch. Hydrocladial internodes long, slender, perisarc moderately thick, smooth, nodes merely transverse constrictions, distinct when present, but often absent. Hydrothecae alternate to subalternate, widely spaced, facing frontally, 1 or 2 on internode, if one, about halfway to two-thirds up internode, if 2, one just below and the other just above node. Hydrocladial apophyses short, distal node transverse, deep.

Hydrothecal pedicel cylindrical, slender, variable in length, sometimes with one to several regenerations. Hydrothecae long, slender, slightly asymmetrical, adcauline wall convex, abcauline wall weakly concave, diaphragm distinct, clearly demarcated from hydrothecal wall, transverse or oblique (depending on angle of view) with central wide hydropore. Hydrotheca margin circular, transverse, rim distinctly everted, some hydrothecae with up to 8 marginal replications; perisarc of hydrotheca smooth.

Nematothecae numerous on peripheral tubes of fascicled stem, on hydrorhiza, on apophyses below hydrothecal pedicels, on surface of coppinia and on coppinial tubes; nematothecae small, vase-shaped, sometimes slightly asymmetric, pedicel very short, margin transverse, circular, rim slightly everted.

Coppinia (Stn 122) scarcely visible, embedded in polysiphonic tubes of stem between primary branches, marked by a faint swelling of the stem and numerous projecting nematophorous tubules. Gonothecae small, cylindrical, tightly packed, with low hooded semicircular orifice, a few with an apical peak, walls thick. Tubules issuing from coppinial mass, long, with one or two basal constrictions, some with one or two nematothecae, some with a few nodes along length and some incipiently branched.

Colour. Stems pale honey yellow, hydrocladia paler.

Measurements (μm)

Branch	
length of internode	360–392
width at node	36–52
Hydrotheca	
length of pedicel	108–120
length diaphragm to margin, including replications	392–600
diameter at diaphragm	56– 64
diameter at margin	116–148
Nematotheca	
length	76–108
diameter at margin	36– 40
Coppinia	
maximum length of tube	1050
diameter of tube	56–60
width of gonotheca	64–100

Distribution. Previously known from a depth of 300 m in Sagami Bay, Japan (Hirohito, 1995).

Remarks. Branches are given off from just inside the peripheral tubes of the stem. Hydrothecae in the axils of branches usually have long, undulated or regenerated pedicels. Hydrocladial nodes may be faint or altogether absent. As there is only one coppinia in the sample and the gonothecae are deeply embedded in the mass, sex could not be determined. Nematothecae are so numerous on the hydrorhizal stolons and peripheral tubes of the lower stem region that they impart a rough, prickly appearance to these structures. Hirohito (1995) mentioned the presence of nematothecae on the peripheral tubes of the stem but not on the hydrorhiza.

In all but arrangement of the hydrothecae the present specimens resemble *Zygophylax tottoni* Vervoort, 1987 in which the branching is strictly planar and hydrothecae are not frontally directed. As the present specimens generally conform with descriptions and figures of *Z. sagamiensis* given by Hirohito (1983, 1995) the material is referred to that species. Differences with the present specimen are: (i) the fewer apical peaks on the gonothecae; and (ii) the numerous coppinial nematothecae.

Acryptolaria Norman, 1875

Acryptolaria conferta (Allman)

Figures 11A–D

Cryptolaria conferta Allman, 1877: 17, pl. 12 figs 6–10.—Stechow, 1913: 30.—Jarvis, 1922: 335.—Keller et al., 1975: 148.

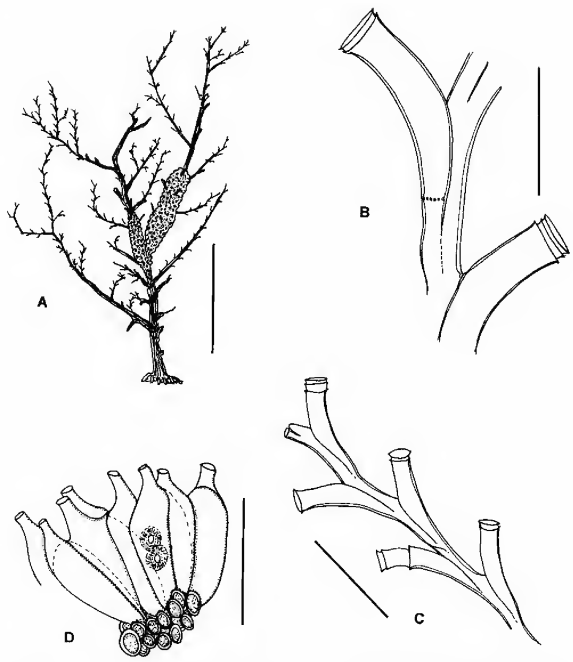
Grammaria conferta.—Broch, 1913: 10.—Broch, 1918: 17–18.

Cryptolaria conferta var. *australis* Ritchie, 1911: 826, pl. 84 fig. 2, pl. 87 fig. 1.—Jäderholm, 1919: 7, pl. 2 fig. 1.—Totton, 1930: 163, figs 19c–e.—Ralph, 1958: 315, figs 4a–g.—Yamada, 1959: 49.—Rees and Thursfield, 1965: 82, 194.—Millard, 1967: 172.

Oswaldaria conferta var. *australis.*—Stechow, 1923a: 11.

Oswaldaria conferta.—Stechow, 1923b: 147.—Leloup 1940: 15.—Picard, 1958: 193.—Marinopoulos, 1981: 176.

Acryptolaria conferta.—Totton, 1930: 164, figs 19a, b.—Kramp, 1932: 68, fig. 32.—Leloup, 1937: 4, 29, fig. 19.—Fraser, 1943: 90.—Fraser, 1944: 210, pl. 40 fig. 189.—Kramp, 1947: 8.—Fraser, 1948:



Figures 11A–D. *Acryptolaria conferta*, stn 44. A, colony with coppinia on stems and branch. B, hydrothecae. C, distal end of branch. D, lateral section through part of coppinia. Scale bar: A, 10 mm; B, 1 mm; C, D, 0.5 mm.

228.—Rossi, 1950: 201, fig. 4a.—Deevey, 1954: 270.—Kramp, 1963: 106.—Millard, 1964: 7, fig. 1A-C, E.—Millard, 1968: 253, 260.—Vervoort, 1968: 99.—Vervoort, 1972a: 41, fig. 12a.—Millard, 1973: 28, fig. 4c.—Millard, 1975: 169, fig. 56.—Millard, 1977b: 106.—Millard, 1978: 188.—Stepanjants, 1979: 51, pl. 9 figs 4A–G.—Millard, 1980: 131.—Hirohito, 1983: 6, 19.—Calder, 1991: 33, figs 19, 20.—El Beshbeeshy, 1991: 63, fig. 13.—Park, 1992: 287.—Boero and Bouillon, 1993: 263.—Calder, 1993: 67.—Blanco et al., 1994: 8, figs 4, 5.—Altuna Prados, 1995: 54.—Bouillon et al., 1995: 51.—Hirohito, 1995: 104.—Calder. 1997: 87.—Schuchert, 2001: 62, figs 48A, B.

Acryptolaria conferta var. *conferta*.—Ralph, 1958: 317.

Acryptolaria conferta australis Millard, 1964: 9, figs 1D, F–G.—Vervoort 1966: 115, fig. 15.—Rees and Vervoort, 1987: 37, fig. 6e.

Acryptolaria conferta conferta.—Vervoort, 1985: 282.—Ramil and Vervoort 1992: 41, figs 7a, b.

Material examined. Stn 44, TM K2776, NMV F91317, many colonies on pebbles and primnoid gorgonian fragment; one colony consisting of 2 large stems (one stem fertile) and several simple stems, other colonies of several large infertile stems, specimens alcohol-preserved.

Description. Simple and branched colonies connected by hydrorhiza reptant on gorgonian. Larger branched colonies flabellate, up to 50 mm high and 35 mm wide, stems to 1 mm wide at base; colonies arising from a thick plug of stolons, simple stems from single stolons. Stem and branches of flabellate colonies heavily fascicled, with roughly longitudinal polysiphonic tubes running upwards from stem and along branches; ultimate parts of branches (hydrocladia) monosiphonic. Branching irregular, of up to 3 orders, branches given off behind a hydrotheca, best seen in distal parts of colony. Monosiphonic branches weakly geniculate, given off from behind a hydrotheca.

Hydrothecae biseriate, alternate, scarcely overlapping, often frontally directed; on monosiphonic branches biseriate arrangement of hydrothecae sometimes replaced by incipient whorls of three around hydrocladium; on fascicled parts of stem and branches hydrothecae often not strictly alternate, immersed in polysiphonic tubes with only distal part or margin visible. Hydrocladial hydrothecae long, tubular, bending outwards at an angle of 40–50° to hydrocladial axis; adcauline wall convex, often a slight change in convexity where wall becomes free; free part about same length as adnate part, hydrotheca narrowing proximally along adnate wall, sometimes fading into a ragged septum. Abcauline wall curving smoothly into hydrocladium, usually a transverse ring of desmocytes just above narrowest part of hydrotheca, marking site of attachment of hydranth. Margin circular, rim transverse to hydrothecal axis, slightly but distinctly everted; up to seven marginal replications common. Perisarc of stem and branches firm, thinning a little on hydrotheca. Hydranths too poorly preserved for description.

Coppinia situated about halfway up stem, spreading for 10 mm along a branch and 5 mm along adjoining stem; coppinia cylindrical, diameter 2 mm, texture rather spongy. Gonothecae radially arranged within coppinia around polysiphonic tubes of stem and branch; flask-shaped, sides more or less straight, conjoined to neighbours, expanding from narrow base to a rounded shoulder surmounted by an erect tubular neck narrowing into a circular non-everted terminal orifice. No protective tubules present. Small spherical planulae visible in some gonothecae.

Colour. Colony translucent honey-gold; hydranths probably of same colour; gonophores creamy pink.

Measurements (μm)

Branch	
distance between hydrothecae on same side of branch	980–1160
width of hydrocladium at junction of free and adnate adcauline wall	144–192
Hydrotheca	
length of free adcauline wall including marginal replications	712–860
length of adnate adcauline wall to desmocyte ring	200–400
diameter at margin	184–200
Coppinia	
overall length of gonotheca	520–528
width of gonotheca across shoulder	136–192
length of gonothecal terminal neck	96–160
diameter of gonothecal terminal orifice	44–48

Distribution. Moderate to deeper waters of all oceans (Vervoort and Watson, 2003).

Remarks. The verticil of three hydrothecae occasionally present on monosiphonic hydrocladia approaches the generic definition of *Cryptolarella* Stechow, 1913 in which the hydrothecae may be triserially disposed around the stem. I cannot find in the literature any mention of the more consistent feature in the present specimens of the frontally directed hydrothecae, all descriptions reporting hydrothecae either lying in the plane of ramification or exceptionally, backwardly or forwardly directed at the base of each new hydrocladium (Ramil and Vervoort, 1992). However, as the colonies conform in all other respects with *Acryptolaria conferta*, the material is presently assigned to that species.

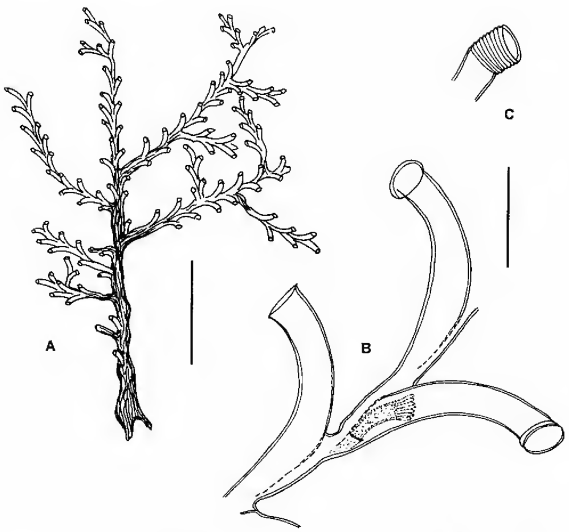
Acryptolaria patagonica El Beshbeeshy

Figures 12A–C

Acryptolaria patagonica El Beshbeeshy, 1991: 67, fig. 14.

Material examined. Stn 90, TM K2777, stem 50 mm high, NMV F91318 stem fragments 5 mm high, all detached from substrate, specimens alcohol-preserved. Stn 90, NMV F91337, malinol-mounted microslide from stem fragment. Stn 94, NMV F91319, colony 100 mm high, two stems 50 mm high joined at base but detached from substrate, three stems to 5 mm high and stem fragment; on primnoid gorgonian, specimens alcohol-preserved. Stn 130, TM K2778, stem 50 mm high, detached from substrate, specimen alcohol-preserved.

Description. All colonies infertile. Stolons reptant on substrate, tubular, narrow, coalescing into erect, almost straight stems; sometimes single hydrothecae arising from stolons between stems. Taller stems to 2 mm thick at base, basal 5–10 mm unbranched; lower stem region strongly fascicled, polysiphonic tubes mostly linear, running up stem and along primary branches. Complex colonies with up to four orders of branching; branches more or less alternate, usually in one plane, primary and subsequent branches often originating just above a hydrotheca, ultimate branches (hydrocladia) and some branches in lower stem region monosiphonic.



Figures 12A–C. *Acryptolaria patagonica*, stn 44. A, colony. B, hydrothecae. C, multiple replications of hydrothecal margin. Scale bar: A, 12 mm; B, C, 1 mm.

Hydrothecae biseriate, tubular, subalternate, usually frontal on branch, long, gracefully arched outwards, abcauline wall concave, often a minor swelling in proximal wall; adcauline wall smoothly convex, one third adnate to hydrocladium, adnate part narrowing a little proximally and fading into hydrocladium; hydrocladium fairly narrow behind adnate hydrothecal wall. Margin circular, transverse to hydrothecal axis, rim slightly everted, almost parallel to hydrocladial axis; margin may have up to 14 close replications bending plane of rim away from axis of hydrotheca. Cauline hydrothecae partially immersed in polysiphonic tubes of stem and primary branches; tubes then often contorted around hydrothecae.

Hydranths contracted and wrinkled; with c. 20 tentacles and clavate hypostome; hydranth attached to base of adnate hydrothecal wall by a ring of tissue.

Perisarc of stem and branches thick and smooth, perisarc of hydrothecae thinner and shining.

Colour. Stems pale honey-yellow fading to almost colourless at tips of branches. Hydranths may have been deep golden-brown.

Measurements (μm)

Branch	
distance between hydrothecae on monosiphonic branch	900–1200
width of hydrocladium where adnate hydrothecal wall becomes free	104–136
Hydrotheca	
length (diagonal) of free adcauline wall including marginal replications	1500–1600
length of adnate adcauline wall from base of hydranth	880–1040
width at base of hydranth	232–256
diameter at margin	416–448

Distribution. Patagonian shelf (El Beshbeeshy, 1991). Also recorded from 415–1060 m at 39°–55°S, near Macquarie Island (Vervoort and Watson, 2003).

Remarks. The larger colonies are rather flexuous and the ultimate monosiphonic branches are quite lax out of fluid. The long, curved hydrothecae are characteristic. The free part of the hydrotheca is tubular but the adnate adcauline hydrothecal wall narrows, becoming increasingly indefinite and rather fibrous in appearance as it passes downward into the hydrocladium.

The frontally directed, long curvaceous hydrothecae resemble *Acryptolaria patagonica* more than any other known species of the genus. Although the habit of the present specimens differs somewhat from descriptions of *A. patagonica*, this may be due to immaturity of the colonies. It is unfortunate that the present material is infertile, since a coppinia would confirm its identity.

Acryptolaria minuta sp. nov.

Figures 13A–C

Material examined. Stn 130, NMV F 91338, holotype, small infertile colony of five small stems, two branched, on dead primnoid gorgonian, malinol-mounted microslide.

Description (of holotype). Tallest stem 9 mm high, broken off at tip, 3.5 mm wide at base; stems branched once in one plane; branched stems arising from a small matted plug of stolons, simple stems from junction of stolonal tubes; taller stems with up to four polysiphonic tubes intergrown and rather contorted proximally, becoming linear distally; polysiphonic tubes running almost to top of stems; stems lightly fascicled; branches given off beside a hydrotheca.

Hydrothecae biseriate, alternate, long, tubular, somewhat frontally directed, scarcely overlapping, curving gracefully outwards at an angle of 50–60° from hydrocladial axis; single hydrothecae on proximal region of larger stems partially immersed in fascicular tubes. Adcauline hydrothecal wall smoothly convex, free wall slightly more than half length of adnate wall; adnate wall narrowing proximally downwards into hydrocladium, base of wall ending in minute knot of perisarc; abcauline wall smoothly concave, passing without interruption into hydrocladium. Margin evenly circular, transverse to hydrothecal axis, very weakly everted, sometimes with several replications of rim. Perisarc of stem and branches firm, thinning a little on hydrotheca. Hydranths deeply retracted into hydrotheca; with c. 12 tentacles.

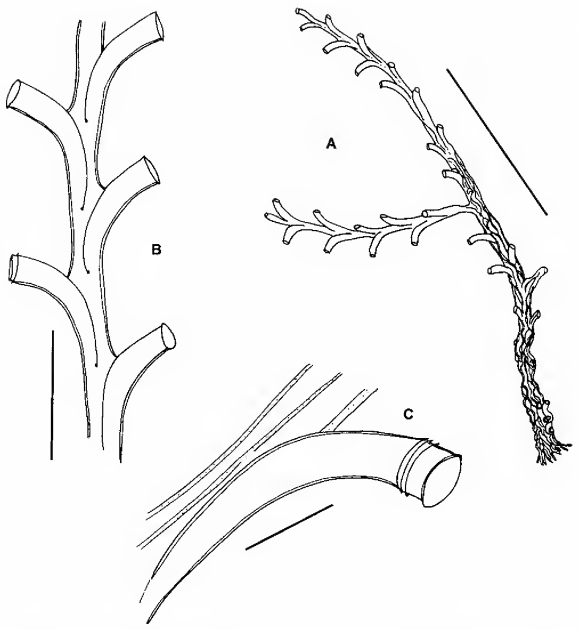
Colour. Pale honey-yellow to colourless.

Measurements (μm)

Branch	
distance between hydrothecae on same side	624–728
width at junction of adnate and free adcauline walls	152–168
Hydrotheca	
length of free adcauline wall including marginal replications	200–368
length of adnate adcauline wall	408–464
diameter at margin	104–128

Etymology. Describes the minute nature of the colonies.

Remarks. The habit of *Acryptolaria minuta* is similar to that of *A. patagonica* described above. The species is, however, considerably smaller in critical dimensions of the hydrocladium and hydrotheca. The slightly everted margin of the hydrotheca



Figures 13A–C. *Acryptolaria minuta* sp. nov., stn 133. A, whole colony. B, part of branch. C, hydrotheca with replicated margin. Scale bar: A, 3 mm; B, 0.5 mm; C, 0.2 mm.

resembles *A. conferta minor* Ramil and Vervoort, 1992 but it is smaller and the hydrothecae are frontally directed in contrast to those of *A. conferta minor* which, according to these authors, lie in the plane of ramification of the branches.

Even if the colonies are immature specimens of a larger species their smaller dimensions and sparsely branched habit matches no other known species of *Acryptolaria*.

Haleciidae Hincks, 1868

Halecium Oken, 1815

Halecium ralphae Watson and Vervoort

Figures 14A–D

Halecium beanii.—Ralph, 1958: 332, fig. 10e, pro parte.
Halecium sessile.—Hirohito, 1995: 27, fig. 7g, pro parte.
Halecium ralphae Watson and Vervoort, 2001: 162, figs 7a–e.

Material examined. Stn 119, TM K2795, infertile colony on dead solitary coral, specimen alcohol-preserved. Stn 44, NMV F91320, small infertile stem detached from substrate, specimen alcohol-preserved.

Description. Colony 60 mm high and 2 mm thick at base; smaller colony 30 mm high. Hydrorhizal filaments reptant on coral; colony aborescently branched in up to three orders, several branches broken off. Branching occurs from below a hydrotheca, stem and branches heavily fascicled, polysiphonic tubes almost linear to undulating, sometimes knotted around origin of branch, tubes running along branches, ultimate branches monosiphonic. Perisarc of stem and proximal branches thick, thinning out on monosiphonic parts.

Monosiphonic branches (hydrocladia) arising from polysiphonic tubes on an apophysis of stem comprising one to three subspherical segments with strong transverse nodes. Hydrocladial internodes long, cylindrical, smooth, widening distally, nodes slightly oblique, tilted away from hydrotheca, marked by a deep constriction and tumescence in perisarc, sometimes an additional short subspherical internode similar to apophysis above node.

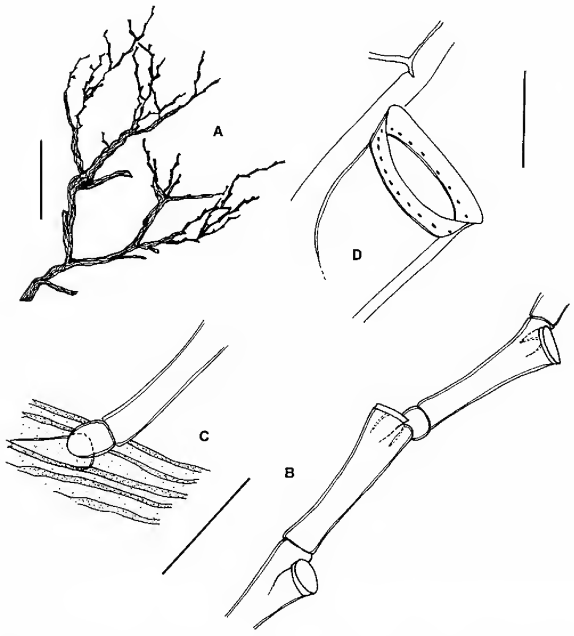
Hydrophores alternate, distal on internode, almost entirely adnate to internode, adcauline wall marked by a seam in perisarc, a semicircular thinning in perisarc below some hydrothecae; abcauline wall contiguous with wall of internode. Hydrotheca free, closely adpressed but not adnate to internode, very shallow, tilted at slightly away from internode, hydrothecal margin very weakly everted, diaphragm distinct, a ring of desmocytes above. Hydranths too poorly preserved for description.

Colour. Stem and fascicled branches honey brown; monosiphonic parts pale brown.

Measurements (μm)

Branch	
length monosiphonic branch internode	580–800
diameter at node	96–120
Hydrotheca	
length adnate wall to diaphragm	100–128
diameter at diaphragm	128–144
depth margin to diaphragm	30–38
diameter of margin	152–154

Distribution. Previously recorded from 475–512 m off the Chatham Islands (Ralph, 1958), shallow water in Japan (Hirohito, 1995) and from 700–1122 m south of Tasmania (Watson and Vervoort, 2001).



Figures 14A–D. *Halecium ralphae*, stn 119. A, colony. B, distal part of branch. C, apophysis of stem and proximal part of branch. D, hydrophore and hydrotheca. Scale bar: A, 5 mm; B, C, 0.5 mm; D, 0.1 mm.

Remarks. Some large undischarged bean-shaped nematocysts visible in the coenosarc of the branches could not be identified. The marginal rims of some hydrothecae have one or two obscure regenerations. Other than the noticeable thinning of the perisarc of the hydrophore below some hydrothecae the material conforms to the description and dimensions of *Halecium ralphae* given by Watson and Vervoort (2001).

Halecium tenellum Hincks

Figures 15A–C

Halecium tenellum Hincks, 1861: 252, pl. 6 figs 1–4.—Hartlaub, 1904: 13, pl. 1 fig. 5.—Hartlaub, 1905: 609, fig. 63.—Jäderholm, 1905: 13, pl. 4 fig. 8.—Hickson and Gravely, 1907: 28.—Ritchie, 1907: 525, pl. 2 fig. 4.—Vanhöffen, 1910: 320, fig. 36.—Hilgendorf, 1911: 540.—Linko, 1911: 26, 240, fig. 5.—Ritchie, 1913: 10, 14.—Broch, 1918: 46, fig. 20.—Jäderholm, 1919: 5, pl. 1 fig. 3.—Stechow, 1919: 41, figs J–K.—Stechow 1923a: 5.—Hargitt, 1927: 507.—Broch, 1927: 115.—Broch, 1928: 61.—Broch, 1933: 17.—Fraser, 1937: 110, pl. 23, fig. 121.—Leloup, 1937: 4, 17, fig. 8.—Fraser 1938: 133.—Fraser, 1939: 159.—Fraser, 1948: 225.—Dawydoff, 1952: 54.—Hamond, 1957: 307, fig. 14.—Millard, 1957: 193, fig. 5.—Vervoort, 1959: 229, fig. 8.—Yamada, 1959: 31.—Leloup, 1960: 220, 230.—Naumov, 1960: 454, fig. 344.—Mammen, 1965: 9, fig. 35.—Vasseur, 1965: 52, 70.—Millard, 1966: 471, figs 11C–F.—Vervoort, 1966: 102, fig. 2.—Millard, 1968: 253, 258.—Vervoort, 1968: 95.—Day et al., 1970: 12.—Hirohito, 1974: 8, fig. 2.—Leloup, 1974: 11.—Millard and Bouillon, 1974: 5, fig. 22.—Rho and Chang, 1974: 136, pl. 1 figs 1–4.—Vasseur, 1974: 158.—Cornelius, 1975: 409, fig. 12.—Millard, 1975: 156, figs 50F–L.—Millard, 1977a: 11.—Millard, 1977b: 106.—Rho, 1977: 252, 414, pl. 71 fig. 63.—Millard, 1978: 193.—Stepanjants, 1979: 104, pl. 20 figs 5A–V.—Millard 1980: 130.—Hirohito 1983: 5, fig. 11.—Stepanjants 1985: 137.— Antsulevich 1987: 106. - Gili, Vervoort, and Pagès, 1989: 81, fig. 10A.—Cornelius and Ryland, 1990: 140, fig. 4.—Calder, 1991: 22, fig. 14.—El Beshbeeshy, 1991: 40, fig. 6.—Ramil and Vervoort, 1992: 90, figs 21f, g.—Medel and Vervoort, 2000: 23.–Schuchert, 2001: 85, figs 70A–E.

Halecium (?) tenellum.—Ralph, 1958: 340, figs 11f, g.

Halecium geniculatum Nutting, 1899: 744, pl. 63 figs 1a–d (not *Halecium geniculatum* Norman, 1867 (= *Halecium halecinum* (Linnaeus, 1758)).

For full synonymy see Cornelius (1975).

Material examined. Stn 120, TM K2779, infertile colony of many stems on stem of *Eudendrium ?cyathiferum*, specimen alcohol-preserved.

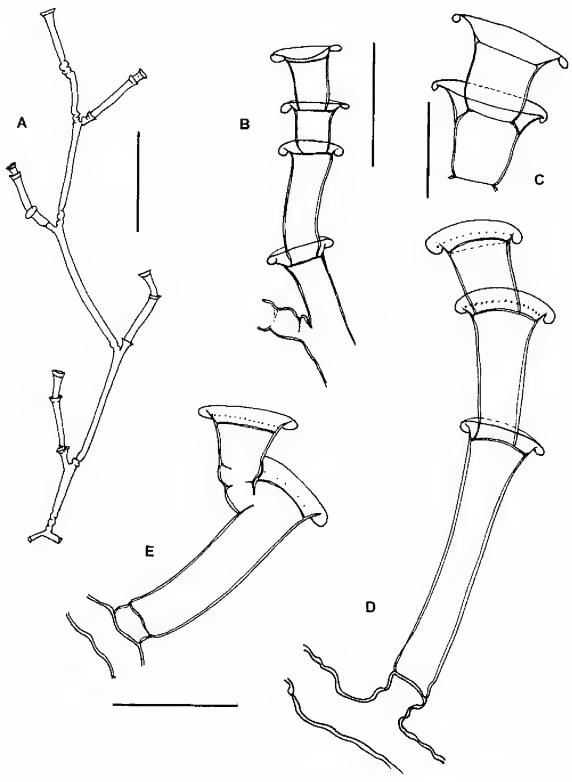
Description. Hydrorhiza tubular, undulating, reptant on hydroid host. Stems to 5 mm high, straggling, given off irregularly from hydrorhiza; stems monosiphonic, beginning with two or three deep transverse annulations, branching thereafter mostly alternate in one plane, straight to sympodial or irregularly dichotomous; stem internodes long, thin, cylindrical, variable in length, perisarc smooth, nodes oblique to transverse, marked by one to three distinct constrictions in perisarc.

Primary hydrophore given off below node, cylindrical, base contiguous with or inclined outwards from internode, variable in length but usually fairly short, hydrotheca moderately deep, diaphragm distinct, transverse, a slight thickening of hydrothecal wall around diaphragm, a faint ring of desmocytes above; margin wide, strongly everted with recurved rim. Hydrophores regenerated linearly up to 10 times, each arising from diaphragm of preceding one, regenerations similar to primaries but length highly variable; base contracted into diaphragm of preceding hydrotheca. Perisarc of hydrorhiza and proximal stem thinning distally, hydrothecal rim very thin.

Colour. White to colourless.

Measurements µm	
Hydrorhiza	
diameter	68–80
Stem internode	
length of proximal internode	1200–1600
length of succeeding internodes	440–1320
diameter at node	60–80
Hydrophore	
adcauline length of primary hydrophore	136–232
length of succeeding hydrophores	68–260
diameter of hydrotheca at diaphragm	78–80
depth, margin to diaphragm	24–36
diameter of marginal rim	130–150

Distribution. Near-cosmopolitan in Atlantic, Indian and Pacific Oceans (if all previous identifications of the species are correct). Depth range, 0–550 m (Millard, 1975). The present record (1046 m) is the deepest for the species.



Figures 15A–E. A–C, *Halecium tenellum*, stn 120. A, single stem from colony. B, linear series of hydrophores. C, hydrophores and hydrothecae with outrolled rims. D–E. *Halecium ovatum*, stn 120. D, linear series of hydrophores. E, secondary hydrophore given off below primary. Scale bar: A, 1 mm; B, 0.25 mm; C, 0.1 mm; D, E, 0.5 mm.

Remarks. The species is small and elegant. The diameter of the widely flared and outrolled, thin hydrothecal rim is twice that of the diaphragm. The desmocytes above the diaphragm are very faint and visible only under high magnification. Some stems have apical tendrils which revert to stolons.

Although the colonies are not strictly fascicled a few stems have one or two extra tubes that become free above the base as independent monosiphonic branches. Because of its small size and epizoic habit *H. tenellum* is easily overlooked and can be identified with certainty only when fertile. The present specimens conform reasonably well with descriptions and dimensions (where given by authors) of *H. tenellum*.

Halecium ovatum Totton

Fig. 15D, E

Halecium ovatum Totton, 1930: 143, fig. 3.—Vervoort, 1972b: 339, fig. 1.—Stepanjants, 1979: 103, pl. 20 figs 1a–g.—Peña Cantero, 1991: 48, pl. 2 figs g, h.—Blanco, 1994: 156.—Peña Cantero and García Carrascosa, 1995: 12, figs 2G, H.—Peña Cantero and García Carrascosa, 1999: 212.

Material examined. Stn 120, TM K2780, NMV F91321, sparse infertile colonies on *Halecium ralphae*, specimen alcohol-preserved.

Description. Colony minute, stolonal; stolons tubular, walls crumpled, thin. Primary hydrophore seated on a short apophysis of the stolon, a transverse to weakly oblique node at base; hydrophore relatively long, cylindrical, smooth, gradually expanding to hydrotheca.

Secondary and tertiary hydrophores arising in a series without basal node from diaphragm of preceding hydrotheca; successive hydrophores progressively shorter. Branching of hydrophore at right angles from below a hydrotheca common, secondary hydrophores shorter, with 2 or 3 partial basal constrictions. Hydrotheca shallow, expanding smoothly from well marked diaphragm to wide margin with strongly recurved and outrolled rim, a clear ring of desmocytes above diaphragm.

Perisarc of hydrorhiza very thin, that of hydrophores thicker, rim of hydrotheca thin.

Colour. Colourless.

Measurements (μm)

Hydrorhiza	
width of stolon	80–104
Hydrophore	
length of primary, proximal node to diaphragm	120–496
width, primary proximal node	59–62
length of succeeding hydrophores	142–316
diameter at diaphragm	120–136
depth, margin to diaphragm	32–44
diameter, marginal rim	176–208

Distribution. Antarctic (Stepanjants, 1979; Peña Cantero and García Carrascosa, 1999).

Remarks. The species is similar to *Halecium tenellum* for which it was originally mistaken in samples from Stn. 120. In size and habit of colony the present specimens most resemble *Halecium ovatum* Totton, 1930 redescribed and figured by Vervoort (1972b). Although the hydrotheca is narrower and shallower than that of *H. ovatum*, in the absence of gonosome the material is assigned to that species.

The stolons of *H. tenellum* and *H. ovatum* entwine on the same substrate and although difficult to differentiate, the two species can be distinguished by the strictly stolonal habit of *H. ovatum*, its broader, undulating and thinner-walled hydrorhizal stolons, branching of the subsidiary hydrophores from below the primary hydrophore, the greater overall cauline dimensions, the less strongly flared and outrolled rim and the ratio of diameter of hydrothecal rim to width of diaphragm (in *H. ovatum* 1.5:1, in *H. tenellum* 2:1).

Halecium delicatulum Coughtrey

Figures 16A–C

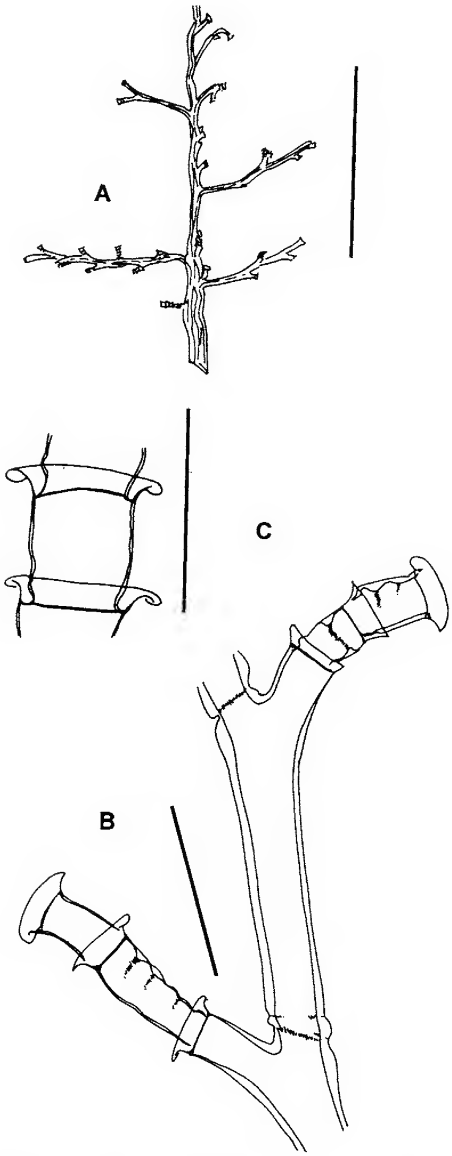
Halecium delicatulum Coughtrey, 1876b: 299.—Coughtrey, 1876a: 26, pl. 3 figs 4, 5.—Stechow, 1913: 144.—Stechow, 1913: 9, 79.—Stechow, 1923a: 5.—Bale, 1924: 235.—Ralph, 1958: 334, figs 11e, h–n, 12 a–p.—Pennycuik, 1959: 173.—Yamada, 1959: 31.—Naumov and Stepanjants, 1962: 94, figs 16, 17.—Rees and Thursfield, 1965: 106.—Millard, 1966: 464, fig. 10L.—Ralph, 1966: 158.—Millard, 1968: 253, 256.—Day et al., 1970: 12.—Blanco and Bellusci de Miralles, 1972: 7, figs 3–5.—Naumov and Stepanjants, 1972: 34, 52.—Stepanjants, 1972: 72.—Vervoort, 1972a: 27, figs 4, 5.—Vervoort, 1972b: 341, fig. 2a.—Watson, 1973: 166.—Leloup, 1974: 10.—Millard, 1975: 145, figs 47F–L.—Watson, 1975: 159.—Millard, 1977a: 7, figs 1C, D.—Millard, 1978: 193.—Stepanjants, 1979: 105, pl. 20 figs 4A–V.—Watson, 1979: 234.—Hirohito, 1983: 5, 11.—Rho and Park, 1983: 41, pl. 2 figs 1–3.—Aguirrezabalaga et al., 1984: 90.—Rees and Vervoort, 1987: 25, fig. 5.—Aguirrezabalaga et al., 1988: 222.—Ramil et al., 1988: 72, fig. 2; Gili, Vervoort, and Pagès, 1989: 78, fig. 7B.—Altuna and García Carrascosa, 1990: 54.—Genzano, 1990: 38, figs 2–5.—El Beshbeeshy, 1991: 32, figs 4a, b.—Roca et al., 1991: 70: 14.—Genzano and Zamponi, 1992: 40, fig. 17.—Park, 1992: 286.—Ramil and Vervoort, 1992: 82, figs 20a–c.—Branch and Williams, 1993: 11.—Genzano, 1994: 5.—Watson, 1994: 66.—Altuna Prados, 1995: 54.—Bouillon et al., 1995: 45.—Hirohito 1995: 20, figs 5a–c, pl. 1, fig. C.—Park, 1995: 10.-Genzano, 1996: 290.—Medel and Vervoort, 2000: 12.

Halecium flexile Allman, 1888: 11, pl. 5 figs 2, 2a.
Halecium gracile Bale, 1888: 759, pl. 14 figs 1–3
Halecium parvulum Bale,1888: 760, pl. 14 figs 4, 5.

Material examined. Stn 122, NMV F91343, NMV F91344, malinol-mounted microslides, colony of three damaged infertile stems, on *Eudendrium*.

Description. Two stems simple, stolonal, the other, the tallest 16 mm high, lightly fascicled. Tubes of fascicled stem running about two thirds distance up stem; stem thereafter monosiphonic with a few alternate branches standing out stiffly almost at right angles to axis, smaller branchlets arising at intervals along stem. Monosiphonic branch internodes long, nodes oblique to almost transverse, sloping almost parallel to primary hydrophore, weakly to deeply constricted, deeper nodes with tumescence above and below. Hydrophores alternate, distal on internode, a smooth, outwardly directed continuation of internode.

Primary hydrophores variable in length, cylindrical, expanding a little to below hydrotheca, perisarc smooth; some older hydrophores on lower stem region deeply corrugated; a secondary hydrophore sometimes given off from primary; linear series of up to eight hydrophores common, each hydrophore



Figures 16A–C. *Halecium delicatulum*, stn 122. A, distal part of colony. B, monosiphonic branch. C, hydrophores, enlarged. Scale bar: A, 5 mm; B, 0.5 mm; C, 0.3 mm.

arising from diaphragm of preceding one, usually a strong basal constriction present, successive hydrophores usually becoming progressively shorter. Hydrotheca moderately deep, expanding smoothly to a wide, strongly everted margin with outrolled rim; diaphragm very strong, transverse, some concave with central hydropore, usually a row of desmocytes above.

Perisarc of polysiphonic tubes of stem quite thick, thinning along monosiphonic branches and hydrophore, becoming thin at hydrothecal margin.

Colour. Clear white (preserved material).

Measurements (μm)

Branch	
length of internode	549–765
width at node	109–152
Hydrophore	
adcauline length of primary, to diaphragm	78–117
length of succeeding hydrophores, base todiaphragm	78–312
diameter at diaphragm	137–164
depth, margin to diaphragm	32–59
diameter, marginal rim	220–257

Distribution. Circumglobal in tropical, subtropical and boreal waters (Vervoort and Watson, 2003).

Remarks. The rather stiff mode of branching in the largest colony does not precisely accord with the usually rather lax habit of *H. delicatulum* (pers. obs.) but may be an artefact of preservation. Although the hydrothecae are a little shallower than is normal for *H. delicatulum* I have no doubt the present material is referrable to that species.

Halecium sp.

Figures 17A–E

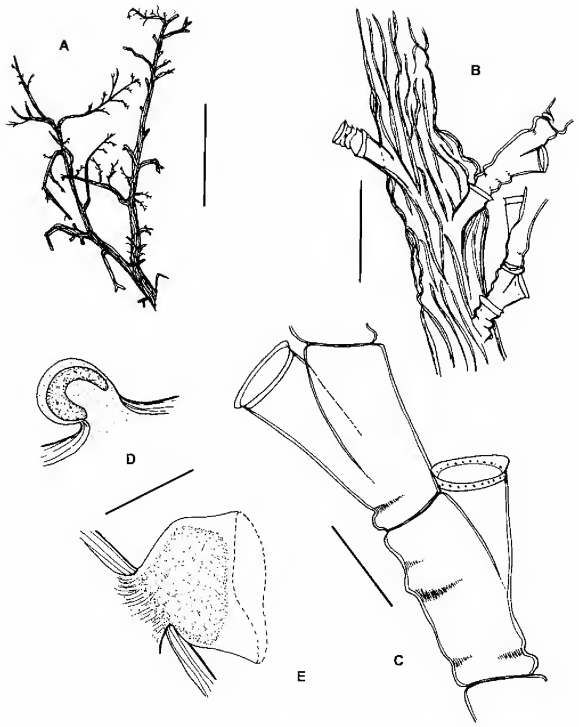
Material examined. Stn 122, NMV F91328, fragmentary remaining upper branches of a large fertile colony, specimen alcohol-preserved. Stn 90, TM K2791, specimen alcohol-preserved, NMV F91345, malinol-mounted microslide, from lower stem and denuded branches of very large colony broken off from base.

Description. Stem (or lower branch) from Stn 122, 5 mm wide at base and 150 mm high, rigid, irregularly branched; branches heavily fascicled, tubes running almost to tips of branches. Ultimate branches (hydrocladia) monosiphonic, irregularly alternate, short, hydrocladium issuing from inside a hydrotheca on peripheral tube of stem or polysiphonic tube of branch, perisarc of stem and proximal branches thick, thinner on hydrocladia. Proximal hydrocladial internode with 1 to 4 deep transverse septa, internodes thereafter short, more or less cylindrical, walls smooth to broadly undulated, nodes opposed, tilted away from hydrophore, deeply incised, internode tumid above and below node.

Hydrophores alternate, occupying distal half of internode, abcauline wall sloping smoothly outwards from axis at c. 30°, adcauline wall variable in length, adnate to below hydrotheca, free wall short. Hydrotheca shallow, free of internode, opposite to or just above node, tilted away from internodal axis at c. 110°, expanding slightly to a weakly everted rim; eversion more pronounced on adcauline than abcauline side; in frontal view hydrothecal margin slightly ovoid; diaphragm distinct, transverse to saucer-shaped with central circular hydropore, a circle of inward-facing thorn-shaped desmocytes above diaphragm. Hydranth with c. 16 tentacles, none well preserved.

Gonothecae arising without pedicel on proximal part of internode opposite a hydrophore; a few immature or broken gonothecae present, minute to small, base subspherical, perisarc very thin.

Colour. Colony from Stn 122 honey brown, fading to white on monosiphonic branches. Colony from Stn 90 pale yellowish-green.



Figures 17A–E. *Halecium* spec., stn 90. A, colony. B, polysiphonic stem with monosiphonic branches. C, monosiphonic branch with hydrophores. D, young gonotheca erupting from stem. E, more advanced gonotheca, distal end damaged. Scale bar: A, 50 mm; B, 1 mm; C, 0.2 mm; D, E, 0.1 mm.

Measurements (μm)	
Monosiphonic branch	
length of proximal internode	120–440
length of succeeding internodes	600–820
width at node	160–280
Hydrophore	
length of adnate adcauline wall	304–416
length of free adcauline wall	56–100
Hydrotheca	
diameter at diaphragm	232–264
depth margin to diaphragm	48–60
diameter at margin	304–320
Gonotheca	
width of immature gonotheca	120

Remarks. The heavily fascicled branches are woody and very brittle. There is little tendency to secondary branching and there are few regenerated hydrophores in the colonies. Although most hydrophores are oppositely arranged on the hydrocladium, there is a tendency to frontal displacement on some branches.

The few small gonothecae present were noted only during detailed examination of the material. They may be female, but the very thin perisarc is so collapsed and torn that the shape of the mature gonotheca could not be reconstructed or the sex determined. Species with strongly fascicled colonies considered were the near-cosmopolitan *Halecium beanii* (Johnston, 1838), *H. luteum* Watson, 1975 from Tasmania and *H. jaederholmi* Vervoort, 1972b, known from Antarctic and subantarctic waters. However, structure and dimensions of the hydrotheca and shape of the internode of these species all differ from the present specimen. As the material is fragmentary it is not to assigned to species.

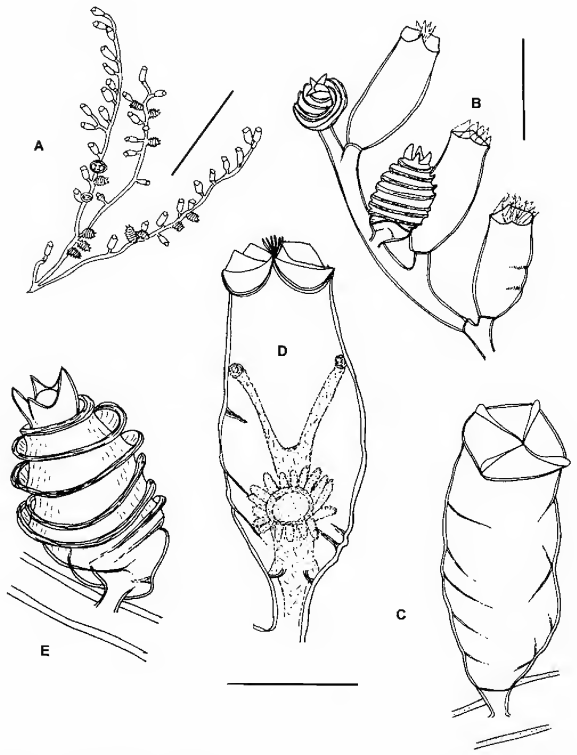
Sertulariidae Lamouroux, 1812

Calamphora Allman, 1888

Calamphora quadrispinosa sp. nov.

Figures 18A–E

Material examined. Stn 94, NMV F91325, holotype, specimen alcohol-preserved, NMV F91346 malinol-mounted microslide from holotype, large colony on *Symplectoscyphus*. Stn 44, TM K2783, paratype, small colony on *Eudendrium*, specimen alcohol-preserved. Stn 120, NMV F91324, paratype, colony on *Symplectoscyphus paulensis*, specimen alcohol-preserved. Stn 130, TM K2784, paratype, on dead coral fragment, specimen alcohol-preserved. Stn 46, TM K2785, small colony on *Eudendrium*, specimen alcohol-preserved.



Figures 18A–E. *Calamphora quadrispinosa* sp. nov., stn 94. A, three stems, part of colony. B, stem, enlarged. C, hydrotheca with intact flanged operculum. D, hydrotheca with ragged opercular valves after eruption of the hydranth; ligaments connecting hydranth to wall of hydrotheca. E, gonotheca. Scale bar: A, 10 mm; B, 1 mm; C, D, E, 0.5 mm.

Description (of holotype and paratypes). Stolonal colonies tangled amongst host hydroids. Stolons simple, tubular, smooth, perisarc moderately thick, smooth to undulated, firmly attached to host, becoming free at intervals as monosiphonic stems, sometimes sparingly branched.

Hydrothecae pedicellate, arising singly, more or less regularly along one side of stolon or branch; hydrothecae upright or inclined at various angles, barrel-shaped or slightly asymmetrical (depending upon angle of view), body narrowing a little below margin, walls smooth to weakly undulated, usually in proximal third; body narrowing into a tubular pedicel; diaphragm thick, transverse to slightly oblique, hydropore central, circular, with short upturned collar. Margin transverse to axis, quadrate, distinctly everted with four broad, sharply pointed cusps separated by low embayments. Operculum of 4 thin triangular valves; in immature hydrothecae valves meet in a low upturned flange decreasing in height from hydrothecal margin to centre; in mature hydrotheca remnants of valves meeting in a central, ragged, upturned tuft. Perisarc of hydrotheca moderately thick proximally, thinning distally.

Hydranth (preserved material), columnar, with c. 16 tentacles and a wide, annular hypostome; no diverticulum or annular fold but a long bifid ligament issuing from below tentacle ring, joining hydrothecal wall in distal third.

Gonothecae arising from stolon, usually beside a hydrotheca; pedicel short, thick; mature gonotheca barrel-shaped, body with six to nine deep flanges, deepest in distal third, shallower proximally; aperture a dome of tissue surrounded by four long, equidistant, more or less inwardly curved spines. Sex of gonophores could not be determined.

Colour. White (preserved material); may have been pale yellow in life.

Measurements (μm)

Stolon-stem	
diameter	192–216
distance between hydrothecal pedicels	1060–1040
Hydrotheca	
length pedicel, adcauline side	64–224
length diaphragm to margin	1100–1280
maximum width	506–561
diameter at diaphragm	184–216
diameter at margin	440–480
height of marginal cusp	70–80
Gonotheca	
length of pedicel	120–176
distal width of pedicel	160–200
maximum diameter	520– 640
depth of ridges	68–100
width across margin	208–240
height of marginal cusps	76–120

Etymology. Named for the four claw-like spines of the gonotheca.

Remarks. There are no nodes in either the hydrorhizal or free stolons, only infrequent constrictions marking probable sites of breakage and repair. The free stolons (branches) are predominantly monosiphonic with some tendency to polysiphony by fusion of two stolons over short distances. The branches are usually loosely curved, and this together with adherence of the stolons to the substrate results in considerable tangling around the stems and branches of the hydroid host. The hydrothecae are usually single but occasionally two may be given off from opposite sides of the branch. Although the hydropore is centrally located, the base of the hydranth sometimes appears to be attached beside, rather than through the hydropore; a ring of large granules (seen in partially cleared specimens) marks the site of attachment. The operculum is retained after eruption of the hydranth and becomes torn into apical tufts presumably from repeated movement of the hydranth. This difference between the flanged operculum of immature hydrothecae and the fragmented tufts of mature hydrothecae is striking, and if the two forms were not present on the same colony the hydrothecae could easily be mistaken for two different species. The bifid ligaments supporting the extended hydranth are visible only when the hydranth is retracted. Nematocysts present in the tentacles and coenosarc of the stolons could not be identified. The colonies are abundantly fertile, the claw-like marginal spines of the gonotheca being characteristic. As no ova were seen in the gonophores the sex is presumed to be male.

Genera considered were: *Sertularella* Gray, 1848, *Thyroscyphus* Allman, 1877, *Symmetroscyphus* Calder, 1986 and *Calamphora* Allman, 1888. *Sertularella* was rejected as the specimen has no clear abcauline diverticulum; as the material is stolonal *Thyroscyphus* was rejected; *Symmetroscyphus* was also rejected as the hydrotheca of that species is symmetrical.

Calamphora is said to possess a diverticulum situated on the adhydrorhizal side of the hydranth (Millard, 1975) which in a stolonal colony is assumed to be the adcauline side. No evidence of such a structure was found in the present material; it is possible however, that from some angles of view, strands of ligament in inadequate material could be mistaken for diverticula.

Although Vervoort (1968) considered *Calamphora* to be inseparable from pedicellate *Sertularella* it nevertheless seems useful to retain the genus for exclusively pedicellate sertulariid species.

Calamphora quadrispinosa is the most abundant species in the collection.

Staurotheca Allman, 1888

Staurotheca vanhoeffeni (Peña Cantero, García Carrascosa and Vervoort)

Figures 19A–E

Staurotheca vanhoeffeni Peña Cantero et. al., 1996: 1–10, figs 1–3.—Peña Cantero et al., 1997: 373, fig. 12.

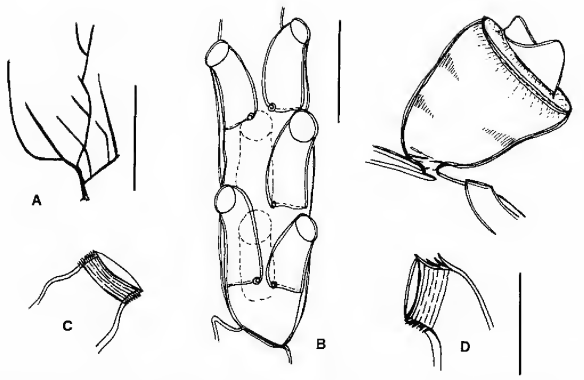
Dictyocladium affine.—Vanhöffen, 1910: 331, figures 44a–c.

Thuiaria affinis.—Stepanjants, 1979: 95, pl. 18 figs 1A, B, pl. 24 figs D–F.

Selaginopsis vanhoeffeni.—Peña Cantero and García Carrascosa, 1994: 121, figs 3j–n.

Material examined. Stn 44, NMV F91322, several sparingly fertile branch fragments, specimen alcohol-preserved. Stn 122, TM K2781, specimen alcohol-preserved, NMV F91347, malinol mounted microslide from infertile colony detached from substrate

Description. Colony stiff and woody, stem 2 mm thick at base, detached from hydrorhiza. Stem sparsely branched in one



Figures 19A–E. *Staurotheca affinis* stn 44. A, part of colony. B, branch internode. C, D, replicated hydrothecal margins. E, female gonotheca. Scale bar: A, 50 mm; B, E, 1 mm; C, D, 0.5 mm.

plane, primary branches rather geniculate, pointing upwards, straight or curved, a few second order branches present. Stem and lower branches fascicled, tubes consisting of a sheath of more or less concentric layers of perisarc surrounding stem; sheath thick proximally, layers becoming fewer but lumpy along branches, completely enclosing branches but branches visible through transparent outer perisarc. Hydrocladia (branches) long, straight, internodes variable in length, 1–10 groups of hydrothecae on internode, nodes oblique to transverse, deeply constricted.

Hydrothecae flask-shaped, immersed in internode, walls not in contact, typically 3 but sometimes 4 (on older hydrocladia) arranged in a verticil around internode, base of each slightly upwardly displaced with respect to others; a proximal athecate section of internode below basal-most hydrotheca. Adcauline hydrothecal wall straight to weakly convexly curved proximally, curvature more convex in distal third, abcauline wall almost straight to faintly concave with outward flexure below marginal rim; base of hydrotheca flat to weakly concave, a thick knot of perisarc at base of adcauline wall. Margin of hydrotheca circular, a tilted slightly upwards, edentulate, not everted, protruding just clear of internode, rim often ragged and produced into a short collar by numerous fine replications; operculum a thin, low dome.

Female gonothecae given off branch above a hydrotheca; pedicel short, wide, slightly bent, merging into gonotheca; body of gonotheca heart-shaped, widening from base to rounded shoulder, walls smooth to faintly undulated, distal end a platform with central wide orifice surrounded by a low collar and a pair of wing-shaped lobes, side of collar slightly outwardly turned and facing adcaudally. Perisarc very thick. No male gonothecae found.

Colour. Colony uniformly dark brown

Measurements (μm)

Branch (hydrocladium)	
length of internode	1360–6000
width at node	320–400
length of infrathecal internode	360–840
width across hydrothecal pair, margin to margin	840–1100
Hydrotheca	
length (diagonal) across adcauline wall	900–1000
length of abcauline wall	780–1000
maximum width	312–384
width across floor	344–400
diameter at margin	280–336
Gonotheca	
length, base (excluding pedicel) to shoulder	1360–1460
width across shoulder	1360–1420
length of pedicel	140–200
width of pedicel at base	200–300
height of apertural collar	360–480
diameter of collar	700–900

Distribution. Circumantarctic (Peña Cantero et al., 1997).

Remarks. The stiff woody colony of the most intact specimen matches previous descriptions of *Staurotheca vanhoeffeni*. Dimensions of the two undamaged female gonothecae from stn 44 fit those given by Vanhöffen (1910). Stepanjants (1979) and Peña Cantero et al., (1997) described and figured male gonothecae: none are present in the Macquarie Island material. None of these authors mention the distinct knot of perisarc at the base of the adcauline hydrothecal wall. The fascicular tubes envelop the proximal part of the stem in contorted, more or less concentric layers of thickened, tough perisarc.

Symplectoscyphus paulensis Stechow

Figures 20A–D

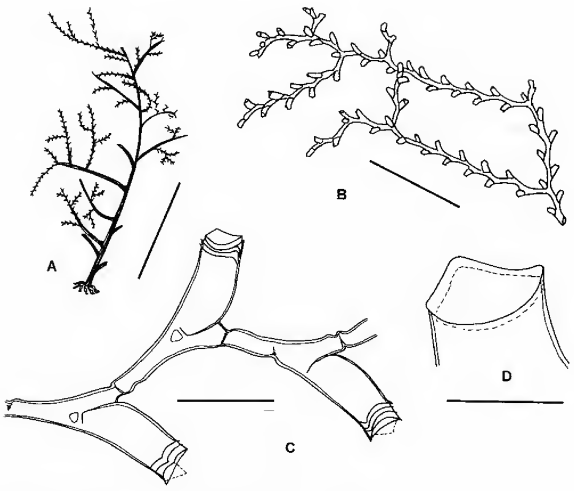
Symplectoscyphus paulensis Stechow, 1923a: 8.—Stechow, 1923b: 172.—Stechow, 1925: 467, fig. 28.—Millard, 1967: 183, figs 4G, H.—Vervoort, 1972b: 180, figs 60b, 61.—Millard, 1975: 317, figs 102A–C.—Millard, 1977b: 107.—Millard, 1978: 199.—Stepan-jants, 1979: 71, pl. 17 fig. 2.—Hirohito, 1983: 51, fig. 24.—Vervoort, 1993: 263, figs 63a–d, 65a.—Blanco, 1994: 154.—Bouillon et al., 1995: 74.

Material examined. Stn 120, TM K2790, NMV F91329, specimens alcohol-preserved; NMV F91348, malinol-mounted microslide, three complete infertile colonies, the tallest 100 mm high and fragments of others, possibly branches shed from these colonies. Colonies heavily overgrown by *Calamphora quadrispinosa*.

Description. Colonies irregularly and profusely branched more or less in one plane. Hydrorhiza a tuft of stolons detached from substrate. Stem of tallest colony 3 mm wide above hydrorhiza, heavily fascicled, stolons growing upwards to become polysiphonic tubes of stem. Branches (hydrocladia) to 30 mm long, slender, polysiphonic tubes often extending a short distance along branch. Branches thereafter monosiphonic (hydrocladia), branched subdichotomously several times at c. 120°, a hydrotheca in each dichotomy.

Hydrocladial internodes long, cylindrical, widening a little below hydrotheca, perisarc smooth, sometimes undulated, internode widening distally; nodes distinct, oblique to almost transverse, marked by a narrowing of perisarc, frequently a tumescence above or below node; a node on each side of hydrotheca in dichotomy.

Hydrothecae alternate, distant, given off almost in one plane just below node at an angle of c. 80° to internodal axis, almost cylindrical, narrowing very slightly to margin, walls smooth, adcauline wall gently convex, adnate adcauline wall short,



Figures 20A–D. *Symplectoscyphus paulensis*, stn 120. A, colony. B, distal monosiphonic branches. C, part of distal branch. D, rim of hydrotheca showing obtuse cusps. Scale bar: A, 50 mm; B, 10 mm; C, 1 mm; D, 0.5 mm.

becoming free opposite or just below node, free wall convex to almost straight, but less curved than adnate part, at least twice length of adnate part; abcauline wall slightly concave, curving smoothly outward, contiguous with internode. Hydrotheca widest at junction of adnate and free adcauline wall, narrowing a little to margin, floor narrow, flat, a minor thickening of perisarc at base of adcauline wall, a triangular foramen and thinning of perisarc in internode beneath floor.

Margin with 3 low, equidistant cusps separated by broad, rather shallow embayments; margin often with numerous fine replications, operculum of 3 triangular valves. Perisarc of hydrotheca thin, slightly thicker at marginal replications, operculum thin.

Hydranth with c. 24 tentacles, a strand of tissue attaching hydranth to hydrotheca about one-third distance up adcauline wall.

Colour. Pale yellow-brown.

Measurements (μm)

Hydrocladium	
length of internode	1000–1440
diameter at node	120–176
Hydrotheca	
length of free adcauline wall	792–840
length of adnate adcauline wall	328–392
length of abcauline wall	880–960
width at floor	184–280
width at margin	400–480

Distribution. A moderately deep-water species from 680 m in the southern Indian Ocean (Stechow, 1923b), 440 m in the south-west Indian Ocean, 347 m off Mozambique (Millard, 1967), 424–428 m on Vema Seamount (Vervoort, 1972a) and 399–500 m in Antarctica (Stepanjants, 1979).

Remarks. Although flexuous, the apical branches are rather brittle and easily broken. The hydrothecae are mostly arranged in one plane, but on some hydrocladia there is a tendency to face frontally. The small, thin marginal replications are slightly everted and are probably remnants of opercular attachments. The hydrothecae in the branch dichotomies do not differ in size or shape from those on the internodes.

The colonies are so heavily overgrown by *Calamphora quadrispinosa* that it is difficult to distinguish the stolons of that species from the polysiphonic tubes of *S. paulensis*. The syntype of *S. paulensis* is strongly polysiphonic (Vervoort, 1993) while monosiphonic hydrocladia of *S. paulensis* are similar to *S. bathyalis* Vervoort, 1972. *S. bathyalis* was rejected because of its weakly expanding hydrothecae.

The present specimens are the largest colonies of *S. paulensis* ever recorded. Previous records are of small polysiphonic colonies or monosiphonic fragments.

Symplectoscyphus tuba Totton

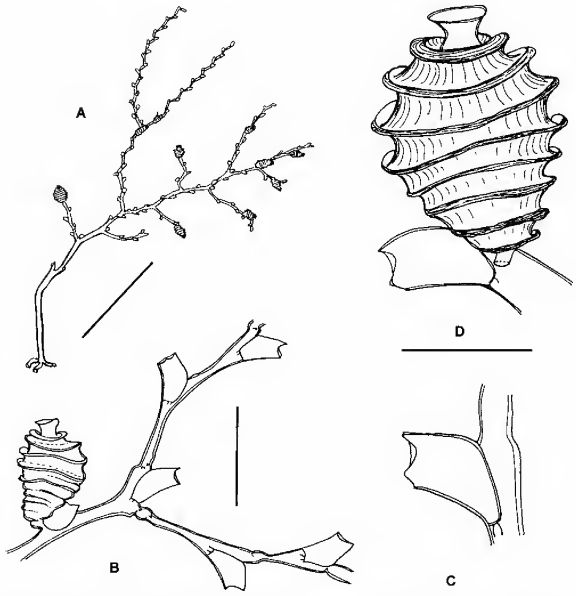
Figures 21A–D

Symplectoscyphus tuba Totton, 1930: 186, figs 37a, b.—Ralph, 1961: 816, figs 18f, g.—Leloup, 1974: 42, fig. 41.—Vervoort, 1993: 272, figs 67a–d.

Sertularella tuba.—Stepanjants, 1979: 76, pl. 1 fig. 4.

Material examined. Stn 94, NMV F91323, specimen alcohol-preserved, NMV F 91349 malinol mounted microslide, fragments of colony detached from substrate. Stn 119, TM K2793, small fertile colony on primnoid gorgonian stem, specimen alcohol-preserved. Stn 120, TM K2794 many broken stems, longest intact stem 40 mm long, specimen alcohol-preserved. Stn 122, TM K2782, small infertile colony on *Eudendrium*, specimen alcohol-preserved.

Description. Hydrorhiza composed of sparse stolonal tubes. Stems monosiphonic, of same diameter as stolons,



Figures 21A–D. *Symplectoscyphus tuba* stn 120. A, single stem from colony. B, branch with axillar hydrotheca. C, hydrotheca. D, gonotheca. Scale bar: A, 10 mm; B, 1 mm; C, D, 0.5 mm.

lower stem rather lax, almost straight proximally, narrowing a little distally. Stems branched alternately, branches widely spaced, usually simple but sometimes rebranched once or twice.

Primary branches up to 12 mm long, directed upward at an acute angle to stem; secondary branching (hydrocladia) if present, pseudodichotomous, forking from below a hydrotheca. Lower branch internodes sub-sympodial, this structure becoming more pronounced distally along hydrocladia. Some hydrocladia terminating in tendrils that rejoin other hydrocladia to form a loose meshwork. Internodes variable in length, slender, widening distally to accommodate hydrotheca, perisarc smooth, node a weak oblique constriction in perisarc sloping away from hydrotheca.

Hydrothecae alternate, distal on internode, short, contracting from base to margin, but sometimes almost tubular; directed upwards at an angle of 35–45° to internodal axis, abcauline wall straight to weakly concave, smoothly contiguous with internode, adcauline wall convex, adnate adcauline wall slightly longer than free wall, almost straight, wall becoming free at node, curvature greater than adnate wall, imparting a distinct angularity to wall. Floor of hydrotheca narrow, flat, a small subcircular foramen in perisarc below. Margin with 3 cusps, adcauline the longest, slightly everted, with 2 abcauline laterals, these less pronounced, rounded; some hydrothecal margins slightly thickened, many replicated. Hydranths with c. 12–16 short tentacles, not well preserved.

Gonothecae abundant, arising on a very short, bent pedicel inserted close beneath hydrothecae on stem and hydrocladia; gonotheca adpressed to hydrocladium, facing distally, ovoid with 8–10 deep, upturned flanges, proximal 2 or 3 shallowest, distalmost flange a collar surrounding orifice; gonothecal wall between flanges deeply concave and strongly vertically striated. Orifice central, wide, trumpet-shaped, upright. Remains of gonophores present in many gonotheca but sex indeterminate.

Colour. Colony colourless, transparent; gonophores may have been pink in life.

Measurements (μm)

Stem	
diameter	?
Internode length	780–1260
diameter at node	88–120
Hydrotheca	
length of abcauline wall	416–440
length of adnate adcauline wall	296–360
length of free adcauline wall including replications	248–312
width across margin (lateral view)	192–216
width across floor	96–120
Gonotheca	
total length including pedicel	1120–1200
maximum diameter including flanges	760–800
diameter of orifice	240–280
length of tube	160–192
length of pedicel	80–112

Distribution. Northern New Zealand, 183 m (Totton, 1930); Antarctica, 145–410 m (Stepanjants, 1979); Chile, 30–60 m (Leloup, 1974); New Caledonia, 650–680 m (Vervoort, 1993).

Remarks. Although the width of the hydrothecal margin and diameter of the gonotheca are somewhat greater than measurements given by Totton (1930), Ralph (1961a) and Vervoort (1993) for *Symplectoscyphus tuba* I have no doubt that the present material is referrable to that species. It is a rather delicate species, of which only small colonies or fragments of colonies have been previously reported. Its long, slender internodes, widely spaced hydrothecae and ovoid, deeply ridged gonothecae are characteristic.

Thyroscyphoides Naumov, 1955

Thyroscyphoides sympodialis sp. nov.

Figures 22A–D

Material examined. Stn 44, NMV F91330, holotype, specimen alcohol-preserved, NMV F91350, malinol-mounted microslide from holotype colony; 20 infertile stems on hydrorhiza of *Eudendrium*.

Description (of holotype). Hydrorhiza tubular, rather contorted, reptant on substrate. Stems simple, to 12 mm high, proximal part of stem of same diameter as stolon; basal-most part of stem with 2 to 4 broad, indefinite annulations, stem thereafter sympodial, sometimes a side branch given off from lower stem. Internodes long, smooth, tubular, becoming shorter along stem, widening distally to below hydrotheca; nodes usually with 1 or 2 deep, oblique constrictions almost parallel with adcauline wall of hydrotheca, a slight tumescence in perisarc above node, sometimes 1 or 2 additional constrictions along internode.

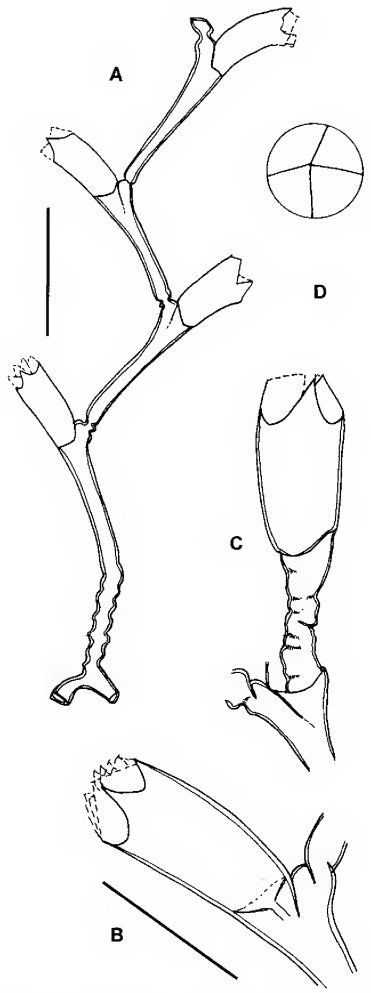
Hydrothecae alternate, arising just below node, body tubular, wide, most sessile but some pedicellate; in sessile hydrothecae abcauline wall smoothly contiguous with outward bend of internode, free adcauline wall smooth, weakly convex to almost straight, a short length of wall adnate to internode; floor of hydrotheca flat, saucer-shaped or funnel-shaped (depending upon angle of view), hydropore slightly offset, fairly wide, a row of desmocytes above marking place of attachment of hydranth. Pedicellate hydrothecae arising from floor of a broken hydrotheca; pedicels of variable length, smooth to corrugated with some internal thickenings; floor of hydrothecae rounded to sinusoidal. In both forms, hydrothecal margin almost circular (anterior view) with 4 sharply pointed triangular cusps separated by deep embayments; operculum of 4 thin pyramidal valves. Hydranth without diverticulum, but with a distinct annular fold; hydranth with c. 20 tentacles.

Perisarc of lower stems comparatively thick, thinning apically along internodes, hydrothecal margin and operculum extremely thin and fragile.

Colour. Transparent, colourless

Measurements (μm)

Stem internode	
length	1000–1640
diameter at node	80–96
Hydrotheca	
length of adnate adcauline wall	168–200
length of free adcauline wall	480–584
length of abcauline wall (to marginal embayment)	336–520
width at margin	248–296
height of marginal cusps	120–184
width of floor	120–136



Figures 22A–D. *Thyroscyphoides sympodialis* sp. nov., stn 44. A, single stem from colony. B, sessile hydrotheca, C, pedicellate hydrotheca. D, anterior view of hydrothecal operculum. Scale bar: A, 1 mm; B, C, D, 0.5 mm.

Distribution. This is the second record of the genus. *T. biformis* is known from deep water in the northern Pacific Kurile Islands (Naumov, 1955).

Etymology. Refers to the strongly sympodial habit.

Remarks. The colonies are almost flaccid out of fluid and the thin, almost transparent perisarc of the hydrothecal margin and operculae are so crushed that few remain intact.

Sessile and pedicellate hydrothecae on the same stem and a hydranth lacking a diverticulum places the species in *Thyroscyphoides* Naumov, 1955. The only other known species of the genus, *T. biformis* Naumov, 1955, differs from *T. sympodialis* in its alternate hydrothecae and its strongly sympodial habit.

Aglaopheniidae L. Agassiz, 1862

Gymnangium Hincks, 1874

Gymnangium japonicum Watson and Vervoort

Figures 23A, B

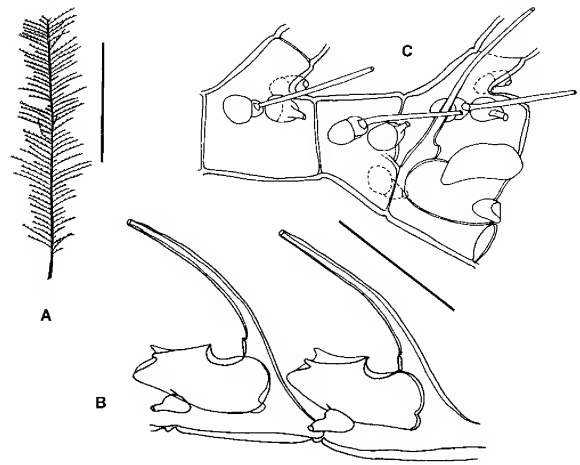
Gymnangium japonicum Watson and Vervoort, 2001: 182, figs 15a–g.

Halicetta sp.—Hirohito, 1995: 293, figs 103e–g, pl. 13 fig. D.

Material examined. Stn 122, TM K2789, specimen alcohol-preserved, NMV F91351, malinol-mounted microslide from same colony; broken infertile stem 50 mm long, detached from substrate.

Distribution. Originally recorded (as *Halicetta* sp.) from a depth of 250 m from Japan (Hirohito, 1995), from 750–900 m south-east of Tasmania (Watson and Vervoort, 2001).

Remarks. The material conforms exactly with the description and dimensions of *Gymnangium japonicum* Watson and Vervoort, 2001 reported from deep water seamounts south-east of Tasmania. The stem is golden brown, hydrocladia yellowish-green.



Figures 23A–C. *Gymnangium japonicum*, stn 122. A, colony. B, hydrocladial hydrothecae. C, cauline internodes with tubular nematocysts (after Watson and Vervoort 2001). A, 20 mm; B, C, 0.5 mm.

Campanulariidae Johnston, 1837

Tulpa Stechow, 1921

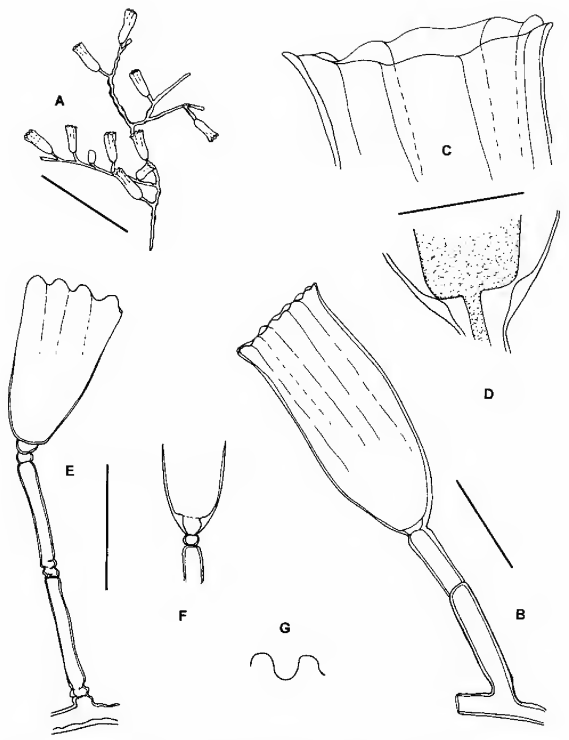
Tulpa diverticula Totton

Figures 24A–D

Tulpa diverticula Totton, 1930: 145, fig. 5.—Ralph, 1957: 844, fig. 7.—Millard, 1977a: 20, figs 5G–H.—Stepanjants, 1979: 35, pl. 6 fig 2.—Gravier-Bonnet, 1979: 33.—Bouillon et al., 1995: 86.

Campanularia diverticula Naumov and Stepanjants, 1962: 72.—Dawson, 1992: 13.

Material examined. Stn 44, TM K2786, specimen alcohol-preserved, infertile colony on *Eudendrium* and other hydroids. Stn 90, TM



Figures 24A–G. A–D, *Tulpa diverticula*, stn 94. A, stem from colony. B, hydrotheca, C, rim of hydrotheca, enlarged, D, base of hydrotheca, enlarged. E–G, *Campanularia hicksoni*, stn 44. E, hydrotheca. F, base of hydrotheca showing thickening and diaphragm. G, rounded marginal cusps. Scale bar: A, 10 mm; B, 1 mm; C, D, 0.5 mm; E, F, G, 0.5 mm.

K2788, specimen alcohol-preserved, sparse infertile colony on another hydroid. Stn 94, NMV F91326, specimen alcohol-preserved, NMV F91352 malinol-mounted microslide from same colony; infertile colony detached from substrate. Stn 119, TM K2787, specimen alcohol-preserved, sparse infertile colony on another hydroid. Stn 120, NMV F91327, sparse infertile colony, specimen alcohol-preserved.

Description. Colony stolonal, hydrorhiza tubular, perisarc smooth and thick with close, fine, vertical internal striae. Hydrothecal pedicels tubular, of variable length, given off more or less regularly, usually from same side of stolon; pedicel ending in a weak constriction below hydrotheca, sometimes 1 or 2 regeneration joints along length; perisarc thinner than on hydrorhiza.

Hydrotheca large, deeply cylindrical to weakly bell-shaped, base rounded with transverse diaphragm with central hydropore, wall thickened below diaphragm, thinning above. Hydrotheca gracefully everted below circular margin, rim with 12–14 shallow crenulations sometimes finely replicated, usually six to eight faint pleats extending partially or completely down into hydrotheca from embayments between crenulations. Hydranth large, with 20–24 tentacles.

Colour. Preserved specimens colourless.

Measurements (μm)

Hydrorhiza	
diameter	280–380
Pedicel	
length	1900–4900
diameter	160–300
Hydrotheca	
diameter at diaphragm	220–340
length, diaphragm to margin	2320–2820
diameter of margin	820–1000

Distribution. North and South Islands of New Zealand (Ralph, 1957) and Antarctic (Stepanjants,1979).

Remarks. The straggling hydrorhiza readily detaches from the substrate. The thin hydrotheca is easily crushed along the pleat-lines during mounting. Many pedicels are segmented with up to five regenerations, apparently repair after breakage. The species is a very common epizooite on other hydroids in the collection.

Campanularia hicksoni Totton

Figures 24E–G

Campanularia hicksoni Totton, 1930: 148, figs 7a–e.—Briggs, 1938: 15.—Rees and Thursfield, 1965: 90, 195.—Blanco and Bellusci de Miralles, 1972, 145: 10, figs 6–19.—Naumov and Stepanjants, 1972: 34, 37.—Stepanjants, 1972: 67, fig. 12.—Stepanjants, 1979: 29, pl. 5 fig. 1.—Blanco, 1984: 18, pl. 13 figs 29–31.—El Beshbeeshy, 1991: 94, fig. 22a.—Blanco, 1994: 159.

Campaularia laevis Hickson and Gravely, 1907: 25, pl. 4 fig. 26.—Ritchie, 1913: 19, fig. 5.—Vanhöffen, 1910: 298, fig. 18 (not *Campaularia laevis* Hartlaub, 1905: 565, fig. P1).

Material examined. Stn 44, TM K2792, NMV F91331, infertile colonies on *Tulpa diverticula* and *Eudendrium*, specimens alcohol-preserved.

Description. Colonies comprising many pedicellate hydrothecae arising from hydrorhiza overrunning stems and hydrorhizae of other hydroids. Stolons tubular, sometimes contorted, perisarc thick. Pedicels simple, unbranched, variable in length, long, tubular, of same diameter as stolon; most pedicels with 3 or 4 obscure proximal annulations, pedicels thereafter smooth, sometimes with a few groups of undulations or joints marking site of regeneration. Pedicel ending in a slightly expanded distal shoulder, a flattened spherule between stem and basal chamber of hydrotheca.

Hydrotheca deeply campanulate, walls expanding smoothly from base to margin, basal chamber narrow, enclosed by outer walls, diaphragm marked by an annular thickening of wall; margin circular, crenulate, with 8–10 apically flattened cusps, embayments between U-shaped, an almost exact reverse image of cusps. Hydrothecal margins often with 2 or 3 widely separated regenerations. Hydranth with c. 16–18 tentacles.

Perisarc of stems fairly thick, thinning distally along hydrothecal body to margin.

Colour. Colonies transparent and colourless to white.

Measurements (μm)

Pedicel	
length	1200–3800
diameter	64–72
diameter of spherule	52–64

Hydrotheca	
depth of basal chamber	40–64
length, diaphragm to margin	640–664
diameter at margin	320–440
height of marginal cusp	40
width of marginal embayment	48–64

Distribution. Antarctic (Totton, 1930; Briggs, 1938; Stepanjants, 1979).

Remarks. Many hydrothecal margins are damaged and most of the undamaged ones fade in stained mounts The few faint pleats extending downwards from the margin in many hydrothecae may result from collapse in mountant.

Dimensions of the present specimens agree fairly well with those of the "short race" of *Campanularia hicksoni* recorded from a depth of 92 m from McMurdo Sound (Totton, 1930) but with the following minor differences: (i) the hydrothecae of the present specimens are a little more campanulate than shown in Totton's figure; (ii) overall length of the hydrotheca of the present specimens is at the lower range of Totton's specimens; and (iii) the marginal diameter of the present specimens falls between Totton's "short race" and those he considered normal for specimens from Cape Adare. Totton's specimens had a variable number of marginal crenulations (9–20); the number of crenulations on the present specimens are at the lower end of this range.

Acknowledgments

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A molecular and morphological review of the asterinid, *Patiriella gunnii* (Gray) (Echinodermata: Asteroidea)

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Abstract O'Loughlin, P.M., Waters, J.M., and Roy, M.S. 2003. A molecular and morphological review of the asterinid, *Patiriella gunnii* (Gray) (Echinodermata: Asteroidea). *Memoirs of Museum Victoria* 60(2): 181–195.

The six-rayed species of the asterinid genus *Patiriella* Verrill from the rocky shallows of southern Australia are reviewed. Based on molecular and morphological evidence, it is judged that *Patiriella brevispina* H.L. Clark is a junior synonym of *Patiriella gunnii* (Gray). Three new species are described: *Patiriella medius* sp. nov., *Patiriella occidens* sp. nov. and *Patiriella oriens* sp. nov. A key to the four species of *Patiriella* is provided.

Keywords Echinodermata, Asteroidea, *Patiriella*, new species, taxonomy, Australia

Introduction

Typically, six-rayed asterinid seastars that occur on the rocky coast of southern Australia are currently referred to either the variably-coloured *Patiriella gunnii* (Gray, 1840) or dark-crimson *Patiriella brevispina* H.L. Clark, 1938. Molecular evidence indicated to Hart et al. (1997) and Byrne et al. (1999) that there were genetically divergent eastern and western forms of what is currently referred to as *P. gunnii* in southern Australia, and that a taxonomic revision was necessary.

Gray (1840) described *Asterina gunnii* from material sent to the British Museum (Natural History) (BMNH, now The Natural History Museum, London) from "Van Diemen's Land" (Tasmania, Australia) by Ronald Gunn. One lot (four specimens, BMNH 40.3.9.10–13) was collected from Sandy Bay, Hobart, in south-eastern Tasmania, and has a note "presumably syntypes, judging from source and Gray's label." A second lot (numerous specimens, BMNH 49.11.19) was from George Town, northern Tasmania, and was considered by A.M. Clark (1966) to be "presumably the types." Dartnall (1970) established one of the Hobart specimens as a lectotype (BMNH 40.3.9.10), and three of the George Town specimens as paralectotypes (BMNH 49.11.19–10, 14, 33). The type locality is thus the Derwent River estuary at Hobart. Verrill (1913) referred *Asterina gunnii* Gray, 1840 to his new genus *Patiriella*.

The lectotype and only one of the paralectotypes (BMNH 49.11.19.33) were present when the BMNH collection was seen by O'Loughlin in April 2002. Two paralectotypes (BMNH 49.11.19.10 and 14) were absent and the remaining individuals from George Town comprised a mixture of *Patiriella* species.

H.L. Clark (1938) correctly distinguished as discrete species variably-coloured and crimson forms of *P. gunnii*. Without reference to the types of *P. gunnii*, he referred the variably-coloured form to *P. gunnii*, and described the crimson form as a new species, *Patiriella brevispina* H.L. Clark, 1938. In this study the taxonomic status of six-rayed species of *Patiriella* is re-assessed after further collecting across southern Australia, and reference to molecular evidence and morphological examination of specimens in the Australian Museum, Sydney (AM), Museum Victoria, Melbourne (NMV), South Australian Museum, Adelaide (SAM), Tasmanian Museum, Hobart (TM), and Western Australian Museum, Perth (WAM). We set out to show by morphological comparison of the lectotype of *P. gunnii* (type locality, Hobart) with the paratypes of *P. brevispina* (type locality, Bunbury in southern Western Australia) that the crimson *P. brevispina* is conspecific with *P. gunnii*, and is thus a junior synonym. The typically six-rayed asterinid seastars which occur in southern Australia are thus the dark crimson *P. gunnii* and three new variably-coloured species described below.

In a few cases it has been possible to assign mentions of "*Patiriella gunnii*" in the literature to one of the species referred to below, and this has been done in the synonymies, but in most cases this has not been possible. Authors who have referred to "*Patiriella gunnii*" are: Lamarck (1816, as *Asterias calcar* variety b; synonymy by Perrier (1876)); Müller and Troschel (1842, as *Asteriscus australis* (part) and *Asteriscus diesingi*; synonymies by Perrier (1876)); Dujardin and Hupé (1862, as *Asteriscus calcar*; synonymy by Perrier (1876)); Perrier (1869,

as *Asteriscus exiguus*; synonymy by Perrier (1876)); Perrier (1876, as *Asterina gunnii*); Sladen (1889, as *A. gunnii*); McCoy (1890, as *A. gunnii*); Farquhar (1895 and 1898, as *A. gunnii*); Verrill (1913, as *Patiriella gunnii*); Fisher (1919); H.L. Clark (1928, 1938, 1946); Cotton and Godfrey (1942); A.M. Clark (1966); Shepherd (1968); Dartnall (1969, 1971, 1980); Rowe and Vail (1982); Zeidler and Shepherd (1982); A.M. Clark (1983); O'Loughlin (1984); A.M. Clark and Downey (1992); Marsh and Pawson (1993); A.M. Clark (1993); Rowe and Gates (1995); Campbell and Rowe (1997); Edgar (1997). The presence of six-rayed specimens of *Patiriella regularis* Verrill, 1867 (normally five-rayed) in New Zealand led to reports by Müller and Troschel (1842 (part), as *Asteriscus australis*), Perrier (1876) and Mortensen (1925) that *Asterina gunnii* occurred in New Zealand. Farquhar (1898) considered the six-rayed material to be *P. regularis*.

Genetics

Methods. Sixty ethanol-preserved specimens provisionally identified as *P. 'gunnii'* (21 locations) and 18 provisionally identified as *P. 'brevispina'* (9 locations), sampled from a broad geographic range, were included in genetic analyses. Genomic DNA was extracted from tube foot tissue using a 5% chelex solution (Walsh et al., 1991) or a CTAB-proteinase K extraction buffer (Saghai-Maroof et al., 1984). A 1580 base pair (bp) portion of the mitochondrial cytochrome oxidase 1 gene (CO1) and the adjacent tRNA-Pro was amplified and sequenced using universal primers F210-CO1 (5' GGTAATGCCAATTATGATTGG 3') and COII 14098-14078 (5' CCTARTTGGGTTCAR TTTGCC 3') (Hart et al., 1997). Subsequently, an internal 830 bp fragment was amplified and sequenced for all specimens using specific primers GUN CO1-L (5' TCCCAAAGCTATCATTCT 3') and GUN CO1-R (5' AGAGATCATTCCAAATCC 3').

PCR (polymerase chain reaction) amplifications (25 µl) contained 50 mM KCl, 10 mM Tris-HCl pH 8.3, 0.1% Triton X-100, 0.005% gelatine, 1.5 mM MgCl2, 800 µM dNTPs, 0.5 µM of each primer, 0.75 units of Taq DNA polymerase, and 1 µl of extracted DNA. All amplifications were performed in a PTC-100 cycler (MJ Research, Watertown, MA) with 40 cycles of 94°C 1 min, 48°C 30 sec, 72°C 30 sec. PCR products were purified with a High-Pure PCR Product Purification Kit (Roche, Mannheim, Germany) and sequenced using an ABI Prism Big-Dye kit. Completed reactions were purified by ethanol precipitation prior to electrophoresis on an automated DNA sequencer (Perkin Elmer, Foster City, CA).

Phylogenetic analysis of aligned DNA sequence data was performed under maximum parsimony (MP) using PAUP 4.0b10 (Swofford, 1998). Phylogenetic confidence was estimated by bootstrapping (Felsenstein, 1985) with 500 replicate data sets analysed with the "full heuristic" option. Published CO1 sequences from *P. 'gunnii'* (U50047-48), *P. 'brevispina'* (U50049-50) and *P. calcar* (U50046) (Hart et al., 1997) were also included in analyses. Genetic divergences were calculated using the Kimura (1980) 2-parameter model of sequence evolution.

Results. Phylogenetic analysis of DNA sequence data yielded over 1000 equally parsimonious trees (863 steps; Fig. 1). However, bootstrap analysis revealed strong phylogenetic structure among haplotypes, with four well-supported clades (100% bootstrap support). Three of the clades corresponded to the so-called *P. 'gunnii'* samples, and the fourth to the so-called *P. 'brevispina'* (Fig. 1). All four clades were deeply divergent (7.5–14.1%), and all were supported by strict consensus analysis of 1000 MP trees. By contrast, haplotypes within each clade exhibited small divergences (typically less than 1.0%) and showed little phylogenetic structure.

Strong phylogeographic structure was detected within *P. 'gunnii'*: all eight Western Australian samples were placed in a western clade, whereas all seven sequences from New South Wales were placed in an eastern clade. The eastern clade was also detected in Victoria and Tasmania, and the western clade was also represented in South Australia. Although no geographic overlap was detected between eastern and western clades, a third central clade exhibited an intermediate distribution, encompassing Tasmania, Victoria, and South Australia (Fig. 1). There was moderate bootstrap support (73%) for a sister relationship between central and western clades.

Morphology

Methods. Specimens for which molecular sequences were obtained, and consequent clades established, were used for the selection of morphological diagnostic characters (MOL codes in lists of material, refers to the code of the tissue sample used to obtain sequence data for molecular phylogeny). These morphological characters were then used to identify specimens in Australian museums. Descriptions of species are based on a combination of observations of specimens in wet and dried and cleared condition. Some specimens were cleared of surface spines and spinelets and thin body wall (skin) using commercial bleach, in order to more clearly observe skeletal plate form and size, and the numbers of secondary plates and papulae in papular spaces. Diagnostic characters are most readily observed on dried and cleared specimens. Most diagnostic characters were found to vary and in many cases to overlap amongst the four species. An attempt was made to relate species and size of specimen to numbers of carinal plates on a ray, width of proximal carinal plates, numbers of spinelets on proximal carinal plates, and length of actinal spines, but these characters were found to be so variable that they were unreliable for diagnostic purposes. Morphological characters finally selected for diagnostic purposes all vary within a species and with size. For determination, more than one diagnostic character is most reliable.

Terminology follows that defined in the glossary and illustrated in Clark and Downey (1992, figs 2, 3), except that "papular space" is used for "papular area" ("restricted area with papular pores") and "papulate areas" is used to refer to the parts of the abactinal surface where papulae occur. "Adradial" refers to the series of actinal interradial plates adjacent to the ambulacral plates.

Results. The morphological analysis confirmed the existence of four six-rayed species of *Patiriella*, corresponding to the four clades established in the molecular study: *Patiriella gunnii* (Gray, 1840) to the so-called *P. 'brevispina'* clade; *Patiriella medius* sp. nov. to the central clade; *Patiriella occidens* sp. nov. to the western clade; and *Patiriella oriens* sp. nov. to the eastern clade (Fig. 1).

Asterinidae Gray, 1840

Patiriella Verrill, 1913

Synonymy and remarks. O'Loughlin et al. (2002) reviewed the status of *Patiriella* Verrill, 1913, and noted that recent molecular phylogenetic analyses of species of Asterinidae (Hart et al., 1997; Byrne et al., 1999; J. M. Waters and M. S. Roy, unpubl.

data) were beginning to provide a basis for a reassessment of asterinid taxonomy. Pending publication of a review of the assignment of species to genera within Asterinidae, the four species treated in this work are retained provisionally in *Patiriella*, most recently diagnosed by Campbell and Rowe (1997).

Key to six-rayed species of *Patiriella*

1. Subambulacral spines predominantly 1 per plate, up to twice length of adradial actinal spines; actinal interradial spines very short, frequently bulbous; abactinal surface uneven; abactinal spinelets prominently spinous, frequently low to subcapitate; proximal papular spaces large, frequently with more than 10 secondary plates and more than 10 papulae per space when R = 30 mm; abactinal colour of adults consistently uniform crimson to brownish red, tube feet orange . . . . .*Patiriella gunnii* (Gray, 1840)
— Subambulacral spines predominantly 2–3 per plate, not up to twice the length of adradial actinal spines; actinal interradial spines not very short or bulbous; abactinal surface even; abactinal spinelets moderately to minutely spinous, frequently columnar; proximal papular spaces not large, fewer than 10 secondary plates and 10 papulae per space when R = 30 mm; abactinal colour variable, not uniform crimson to brownish red, with orange tube feet 2
2. At least a few suboral spines frequently present; adradial actinal spines up to about two-thirds length of subambulacral spines; actinal interradial spines short and fine; carinal plates normally doubly papulate for less than two-thirds ray length, frequently less than half ray length; proximal papular spaces small, frequently up to 3 secondary plates and 3 papulae per space when R = 30 mm; abactinal spinelets relatively small and fine, predominantly narrowing distally, minutely spinous; abactinal colour variable, frequently overall maroon red (not reported with grey or blue, or with black disc); actinal colour off-white, frequently with prominent flecking . . . . . *Patiriella medius* sp. nov.
— Suboral spines rarely present; adradial actinal spines frequently more than two-thirds length of subambulacral spines; actinal interradial spines digitate; carinal plates normally doubly papulate for more than half ray length, frequently more than two-thirds ray length; proximal papular spaces fairly open, frequently with about 6 secondary plates and 6 papulae per space when R = 30 mm; abactinal spinelets relatively coarse, predominantly columnar, slightly narrowing to slightly widening distally, moderately spinous; abactinal colour variable, not overall maroon red 3
3. Form variable, commonly distinctive short rays with interradial margin deeply indented; subambulacral spines frequently projecting fairly prominently; abactinal spinelets coarse, columnar, moderately spinous, frequently widened distally; up to about 8 spinelets on inferomarginal plates when R = 20 mm, up to about 11 when R = 30 mm; abactinal colour frequently dark, with grey or brown or blue, infrequently with red . . *Patiriella occidens* sp. nov.
— Form variable, commonly subhexagonal with interradial margin slightly incurved; subambulacral spines not projecting significantly; abactinal spinelets fairly coarse, columnar, moderately spinous, frequently narrowing distally, up to about 10 spinelets on inferomarginal plates when R = 20 mm, up to about 15 when R = 30 mm; abactinal colour frequently pale, with white or pink or mauve or orange or bright red, disc frequently black (not reported with grey (except in NSW), or blue) . . . . . .*Patiriella oriens* sp. nov.

Patiriella gunnii (Gray)

Figures 1 (as *P. 'brevispina'*), 2a–f, 3a–f, 7b

Asterina gunnii Gray, 1840: 289–290.—Gray, 1866: 16.—McCoy, 1890: 372, pl. 200 fig. 2 (part).

Patiriella gunnii.—Verrill, 1913: 484.—Dartnall, 1970: 74–76, pl. 1.

Patiriella brevispina H.L. Clark, 1938: 166–167, pl. 22 figs 2–3.—Cotton and Godfrey, 1942: 202.—H.L. Clark, 1946: 134–135.—A.M. Clark, 1966: 320.—Shepherd, 1968: 745, 747.—Dartnall, 1969: 55.—Dartnall, 1970: 75–76.—Dartnall, 1971: 47, fig. 1.—Dartnall, 1980: 34, 65.—Rowe and Vail, 1982: 222.—Zeidler and Shepherd, 1982: 402, 412; figs 10.7c, d.—O'Loughlin, 1984: 136.—Bennett, 1987: 346–347, fig.—Rowe and Gates, 1995: 39.—Campbell and Rowe, 1997: 130.—Edgar, 1997: 346, fig.—Hart et al., 1997: 1848–1861, figs 1–4, tabs 1, 2.—Byrne et al., 1999: 188–191, figs 1, 3C, 6 (new synonymy).

Material examined. Asterina gunnii Gray, 1840. Australia, Tasmania, Hobart, Sandy Bay, 2 m, R. Gunn, BMNH 40.3.9.10 (Lectotype: dry; partly cleared; designation by Dartnall, 1970); BMNH 40.3.9.-11, 12, 13 (3 specimens).

Patiriella brevispina H.L. Clark, 1938. Western Australia, Koombana Bay, Bunbury, 9–14 m, E.W. Bennett and H.L. Clark, 26 Oct 1949, AM J6181 (2 paratypes, dry).

Other material (selected for molecular confirmation, distribution and depth data). **Vic.** East Gippsland, off Ninety Mile Beach, 38°42' S, 147°53' E, 22 m, NMV F73255 (1); Western Port, Honeysuckle Point, TM H723 (4); Flinders, ocean platforms, NMV F71744 (3) (MOL 54); NMV F93430 (1) (MOL 180); NMV F93429 (1) (MOL 10); NMV F93435 (4) (MOL 130–131); Port Phillip Bay, Altona, NMV F72130 (1) (MOL 53); Geelong, Mackey St jetty, 2 m, NMV F93441 (1) (MOL 51, 56); "Mullet Holes", 10 km NE Apollo Bay, NMV F93433 (3) (MOL 97–99); Port Fairy, Griffith I., rocky shallows, NMV F93432 (1) (MOL 81); Portland, below lighthouse, 2–3 m, NMV F93440 (1). **Tas.** Eaglehawk Neck, rocky shallows, NMV F71873 (1); Bass Strait, Cape Portland, TM H596 (1); Jacobs Boat Harbour, TM H2941 (1). **SA.** Gulf Saint Vincent, Normanville, NMV F74628 (1) (MOL 60); NMV F74629 (1) (MOL 59); NMV F93434 (1) (MOL 111); NMV F93436 (1) (MOL 102); Eyre Peninsula, Point Westall, near Streaky Bay, NMV F93437 (1) (MOL 55); Nuyts Archipelago, Goat I., 29 m, NMV F93446 (1). **WA.** Esperance, Sandy Hook I., WAM Z9471 (1); Busselton, jetty piles, 4 m, WAM Z8948 (3) (MOL 146); Cockburn Sound, TM H1116 (4); Trigg I., WAM Z9539 (2); Yanchep, lagoon, NMV F93443 (2).

Description (dry and cleared specimens). Up to R = 56 mm; 5–9 rays, predominantly 6 (102 of 116 AM specimens with 6 rays, 10 with 7 rays, 2 with 5 rays, 1 with 8 rays, 1 with 9 rays); form variable from 6 short rounded to pointed rays with interradial margin incurved, to hexagonal; body thick, flat orally, flattened dome aborally, acute angle at

margin; madreporite conspicuous; lacking pedicellariae; gonopores abactinal.

Abactinal surface uneven; papulate areas more extensive than non-papulate areas; secondary plates abundant, very irregular in size and form; proximal radial and interradial plates openly imbricate; proximal papular spaces large, frequently up to 16–20 secondary plates and 16–20 papulae in proximal papular spaces outside disc when R = 30 mm (5–6 secondary plates and 5–6 papulae when R = 20 mm); abactinal plates thick, raised, prominent, crescentic in papulate areas, carinally with double notch and proximal lobe; carinal series variably regular from close to disc to end or near end of rays, frequently doubly papulate to near end of ray when R = 20 mm and larger; distal interradial non-papulate plates closely imbricate, domed, rounded proximally; disc variably distinct, bordering plates variably regular crescentic radial plates and smaller interradial plates, disc frequently obscured by irregular large plates within and distal to disc; abactinal plates granular, covered by glassy convexities, lacking spine-bearing ridge; abactinal spinelets with variable form, frequently widened distally, some capitate or truncate or columnar or narrowing distally or with swollen base, long spines distally, typically about 0.40 mm long when R = 30 mm (0.32 mm when R = 20 mm), distributed over projecting surface of plates; superomarginal plates aligned longitudinally with inferomarginal plates; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, up to about 11 spinelets per plate when R = 20–30 mm; actinal plates in regular series, curving acutely from furrow to margin, some proximal actinal areas not calcified; actinal interradial spines generally thick, very short, columnar to bulbous, distally minutely spinous; actinal interradial proximal plates with 1–2 spines, distally 2–3 (4 rare); adradial row of actinal interradial proximal plates with predominantly 1 short, thick, bulbous to tapered spine, typically up to only half the length of subambulacral spines; adambulacral proximal plates with predominantly 1 (2 rare) thick subambulacral spines, frequently bulbous with waist, form variable from columnar to subspatulate to spatulate, minutely spinous distally; furrow spines 2–3 (4 rare) proximally, fairly thick, form variable from tapered to slightly widened distally; suboral spines rare (7 suboral spines on 1 of 116 AM specimens); oral spines 4–6, predominantly 5.

Live colour. Abactinally uniform dark crimson or reddish-brown (a few AM labels refer to "purple" and "indigo blue"), paler actinally; orange tube feet.

Distribution. Eastern Vic. (off Ninety Mile Beach) continuous to Abrolhos Islands off WA (Loisette Marsh, pers. comm.); Bass Strait; Tas.; under rocks; 0–29 m (molecular confirmation for Flinders (Vic.) to Busselton (WA)).

Remarks. The lectotype of *Asterina gunnii* and the two paratypes of *Patiriella brevispina* seen in this study do not exhibit any significant morphological differences and in particular have single stout subambulacral spines per plate and very short actinal interradial spines. These two diagnostic characters were used by Clark (1938) to distinguish his new species. Clark (1938) also considered the "consistent deep purple to brownish-crimson colour and orange tube feet" of *P. brevispina* to be diagnostically reliable. This observation is confirmed and specimens with these characteristic colours consistently exhibit the morphological diagnostic characters of *A. gunnii*. Dartnall (1970) followed H.L. Clark (1938) when designating and describing the lectotype of *A. gunnii*, and noted that paired subambulacral spines distinguished *P. gunnii* from *P. brevispina*. Dartnall (1970) then considered the lectotype of *A. gunnii* to be exceptional in having single subambulacral spines. The lectotype of *A. gunnii* (R = 24 mm) and paratypes of *P. brevispina* (up to R = 20 mm) are similar in size, and are small specimens of *A. gunnii* (up to R = 56 mm). On the morphological evidence *P. brevispina* is considered here to be a junior synonym of *A. gunnii*.

Hart et al. (1997) and Byrne et al. (1999) found from molecular evidence that *P. 'brevispina'* specimens from eastern Australia (Mornington Peninsula, Vic.) and Western Australia (Perth) were closely related. Eastern and Western Australian specimens of *P. 'brevispina'* were found to be conspecific in this study. Byrne (1995, 1996), Byrne and Cerra (1996), and Long and Byrne (2001) have reported on the reproductive and developmental biology of *P. gunnii* (as *P. 'brevispina'*).

The combination of characters which distinguishes *P. gunnii* from other six-rayed species of *Patiriella* is: consistent uniform dark crimson to reddish brown colour; orange tube feet; larger maximum size; prominent papular spaces with numerous papulae and secondary plates; noticeably spinous abactinal spinelets; predominantly single thick subambulacral spines per plate; and very short thick actinal interradial spines. No evidence was found to confirm the occurrence of *P. gunnii* in NSW, or the depth of 39 m reported by Rowe and Gates (1995, as *P. 'brevispina'*).

Patiriella medius sp. nov.

Figures 1 (as 'central'), 4a–f, 7c

Material examined. Holotype. Victoria, Port Fairy, Griffith I., rocky shallows, 0–2 m, M. O'Loughlin and M. Mackenzie, 29 Dec 2001, NMV F92986 (MOL 72).

Paratypes. Type locality and date, NMV F92987 (3) (MOL 73, 74, 79); NMV F92988 (2 dry, 2 cleared) (MOL 69, 70, 75, 76).

Other material (selected for molecular confirmation, distribution and depth data). **Vic.** W of Wilsons Promontory, Walkerville South, Bear Gully, NMV F71869 (1); Western Port, McHaffie Point, NMV F93174 (4); Flinders, ocean platform, NMV F93171 (2); Port Phillip Bay, Popes Eye, 5–12 m, NMV F93730 (1); Point Addis, 8–13 m, NMV F93165 (3) (MOL 170, 172); "Mullet Holes", 10 km NE Apollo Bay, 0–2 m, NMV F92990 (3) (MOL 94–96); Port Fairy, Griffith I., rocky shallows, NMV F83593 (2) (MOL 50); NMV F93164 (1) (MOL 176); NMV F87171 (1) (MOL 177); Portland, Nelson Bay, 24 m, NMV F73193 (2). **Tas.** Port Arthur, below low tide, TM H809 (1); Bass Strait, Waterhouse Passage, rocky shallows, NMV F71872 (1) (MOL 46); Tamar River, Greens Beach, TM H1107 (21); Somerset, near Burnie, under rocks at low tide, WAM Z9394 (5); Rocky Cape, 5 m, NMV F92989 (2) (MOL 211). **SA.** Cape Jaffa, 14–20 m, SAM K1938 (2); Kangaroo I., Western River, 8–10 m, SAM K1917 (1); Gulf

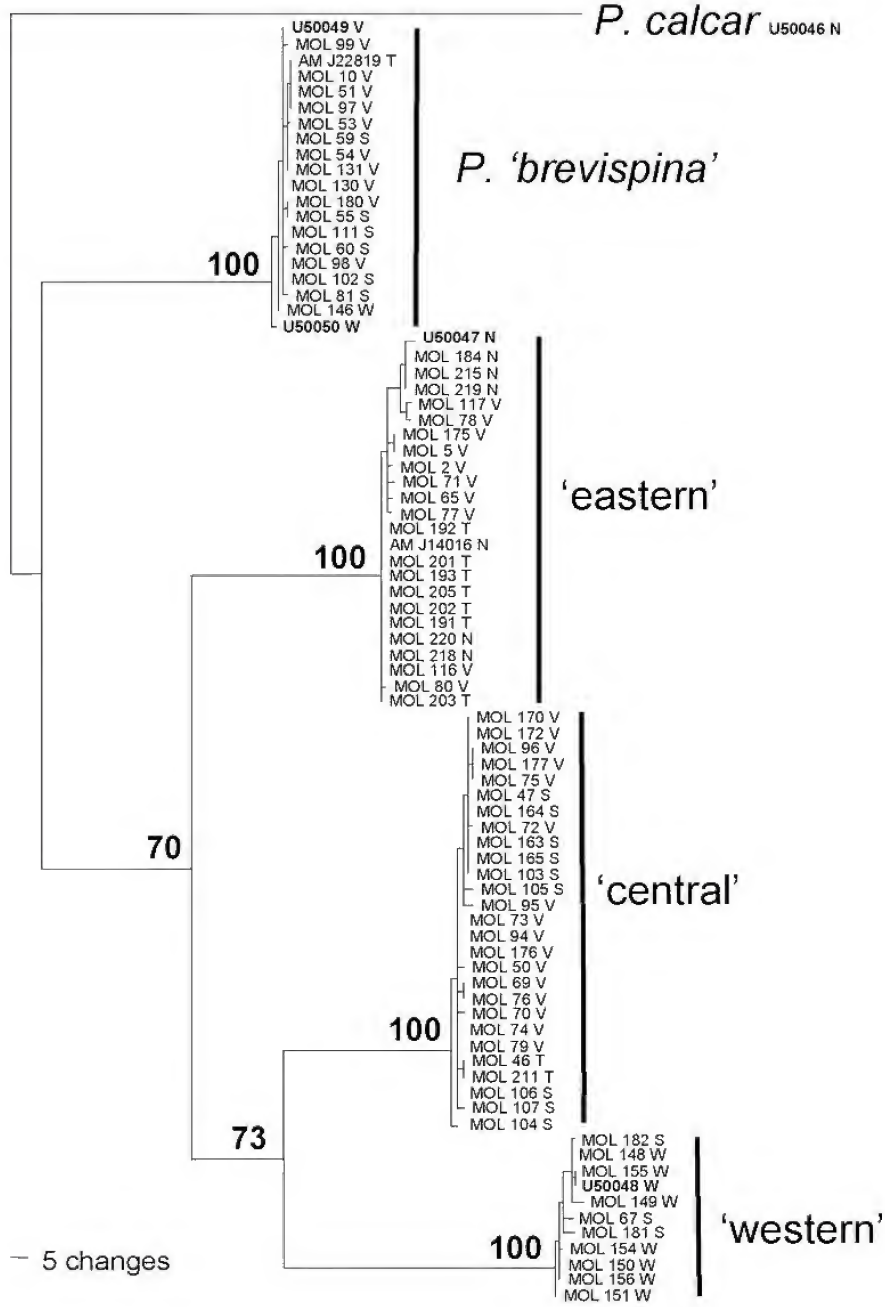

Figure 1. One of 1000+ optimal MP trees (863 steps) derived from analysis of CO1 sequence data. Numbers at nodes are bootstrap percentages based on 500 replicate analyses. MOL codes refer to specimens obtained for the current study. AM codes refer to Australian Museum specimens. Previously published sequences (Hart et al., 1997) are indicated in bold. Geographic origin of samples is indicated: Tasmania (T), Victoria (V), New South Wales (N), South Australia (S), Western Australia (W).

Saint Vincent, Fleurieu Peninsula, Rapid Bay jetty, 8–12 m, NMV F93166 (4) (MOL 163–165); Normanville, rocky shallows, NMV F93163 (4) (MOL 104–107); F93167 (1) (MOL 103); Port Noarlunga, under stones, 1 m, WAM Z9390 (1); Yorke Peninsula, Edithburg, Troubridge Light, 18 m, TM H1359 (1); Sir Joseph Banks Group, 3–14 m, SAM K1923 (3); Investigator Group, 6–8 m, SAM K1901 (1); Eyre Peninsula, near Streaky Bay, Point Westall, rocky shallows, NMV F71856 (1 cleared) (MOL 47, 57); Nuyts Archipelago, 34 m, SAM K1933 (1). **WA.** Hopetoun, east of jetty, rock platform, NMV F73201 (3); Cheyne Bay, intertidal reef, WAM Z9472 (1); Yallingup, under boulders with *P. 'brevispina'* (= *P. gunnii* here) and *P. 'gunnii'* (= *P. occidens* here), 0–1 m, WAM Z9477 (5); Cape Naturaliste, 9 m, WAM Z9404 (1); Dunsborough, Eagle Bay, under rock, 10 m, NMV F93172 (1); Bunbury, 4 km N, WAM Z9411 (1); Fremantle, Halls Bank, under rock, 8 m, NMV F73178 (1).

Description (dry and cleared specimens). Up to R = 38 mm; 5–7 rays, predominantly 6 (134 of 145 SAM, TM and WAM specimens with 6 rays, 9 with 7 rays, 2 with 5 rays); form variable from 6 short predominantly pointed rays with interradial margin incurved, to hexagonal; body flat orally, flattened dome aborally, acute angle at margin; madreporite conspicuous; lacking pedicellariae; gonopores abactinal.

Abactinal surface even; papulate areas slightly more extensive than non-papulate areas; secondary plates few, very irregular in size and form; proximal radial and interradial plates fairly closely imbricate; proximal papular spaces not large, frequently 1–3 secondary plates and 2–4 papulae in proximal papular spaces outside disc when R = 20–30 mm; abactinal plates crescentic in papulate areas, carinally with double notch and proximal lobe; carinal series variably regular from close to disc to near end of ray, rarely doubly papulate beyond half ray length; distal interradial non-papulate plates closely imbricate, domed, rounded proximally; disc variably distinct, bordering plates variably regular crescentic radial and smaller interradial plates, frequently obscured by irregular large plates within and distal to disc; abactinal plates granular, covered by glassy convexities, lacking spine-bearing ridge; abactinal spinelets with variable form, subcolumnar to narrowing and rounded distally with swollen base, minutely spinous distally, typically about 0.36 mm long when R = 30 mm (0.30 mm when R = 20 mm), distributed over projecting surface of plates; superomarginal plates aligned distally with inferomarginal plates; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

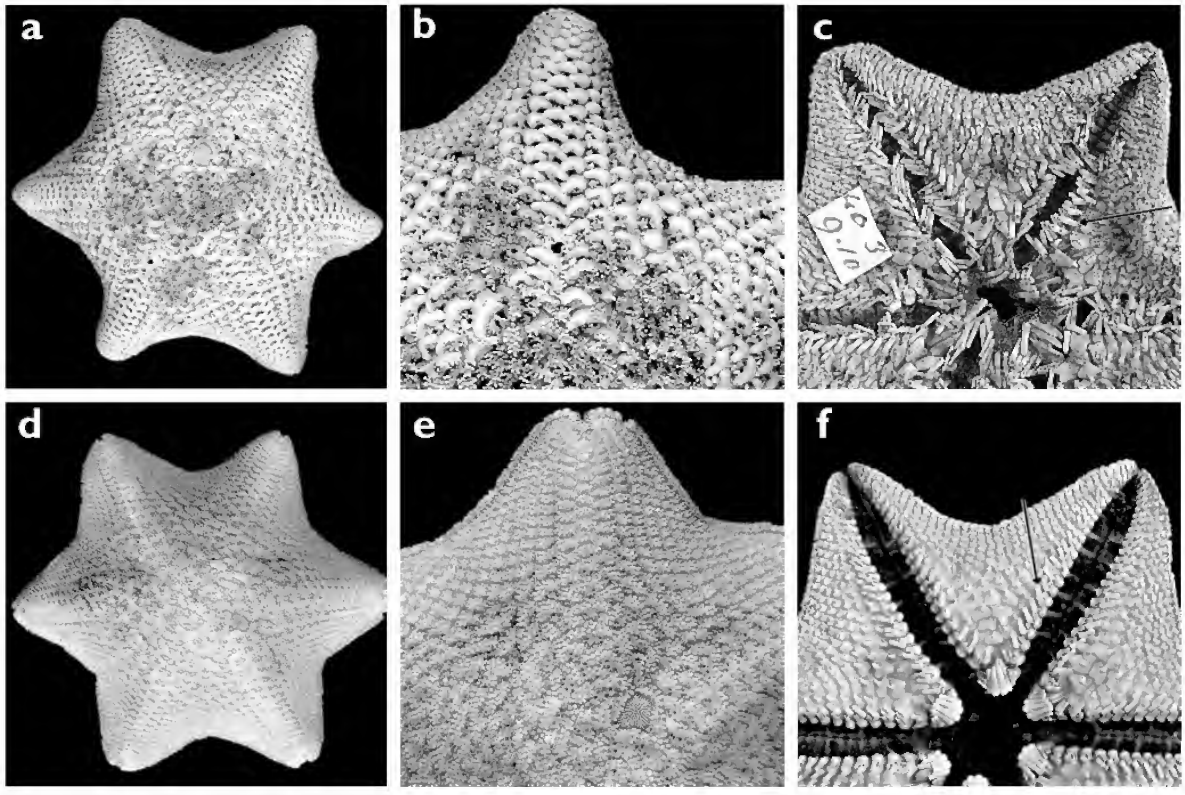

Figure 2. a–c, *Asterina gunnii* Gray, 1840, lectotype, R = 24 mm (BMNH 40.3.9.10, dry). a, abactinal view (extensively cleared); b, abactinal ray (extensively cleared); c, actinal ambulacra and interradius, with single stout subambulacral spines per plate (arrow) and very short interradial spines.

d–f, *Patiriella brevispina* H.L. Clark, 1938, paratype, R = 20 mm (AM J6181, dry). d, abactinal view; e, abactinal ray; f, actinal ambulacra and interradius, with single stout subambulacral spines per plate (arrow) and very short interradial spines.

Projecting inferomarginal plates form margin, widely rounded distally, frequently 10–14 spinelets per plate when R = 20–30 mm; actinal plates in regular series, curving acutely from furrow to margin; some proximal actinal areas not calcified; actinal interradial spines generally fairly slender, tapered, short; actinal interradial proximal plates with 1–4 spines (predominantly 2–3), distally 2–4 very short tapered spines (frequently 3), minutely spinous distally; adradial row of actinal interradial proximal plates with predominantly 2 tapered spines, minutely spinous distally, significantly shorter than subambulacral spines (about half to two-thirds length); adambulacral proximal plates with frequently 2–3 thick tapered subambulacral spines, minutely spinous distally, frequently unequal, form variable from digitate to spatulate to distally bulbous, commonly slightly longer than furrow spines; furrow spines slender, webbed, tapering, predominantly 3–4 (sometimes 5) per plate proximally when R = 20 mm and larger, minutely spinous distally; suboral spines frequently present (at least 1 suboral spine on 68 of 115 AM, SAM and TM specimens examined; 10–12 suboral spines on 42 of 115 specimens); oral spines 5–7, predominantly 6.

Live colour. Abactinally very variable; dark-coloured disc not reported; frequently overall maroon red or red or reddish brown appearance, sometimes fairly uniform pale brown or orange or pink, sometimes with red or mauve or orange or brown or cream or white flecks; a few with margin or rays and interradii coloured differently, or with colour patches; some mottled with dark red, red, maroon, mauve, brown, orange, white; actinally typically off-white with prominent maroon flecking.

Distribution. Walkerville South (W of Wilsons Promontory, Vic.), Bass Strait, Tas., continuous to Fremantle (WA); under rocks; 0–34 m (molecular confirmation for Point Addis (Vic.) to western Eyre Peninsula (SA)).

Etymology. From *medius* (Latin, as a noun in apposition) meaning "between the two", and referring to a distribution across southern Australia between the most easterly distribution of *Patiriella oriens* sp. nov. (below) and the most westerley distribution of *Patiriella occidens* sp. nov. (below).

Remarks. The combination of characters which distinguishes *P. medius* from other six-rayed species of *Patiriella* is: rarely doubly papulate carinally for more than half ray length;

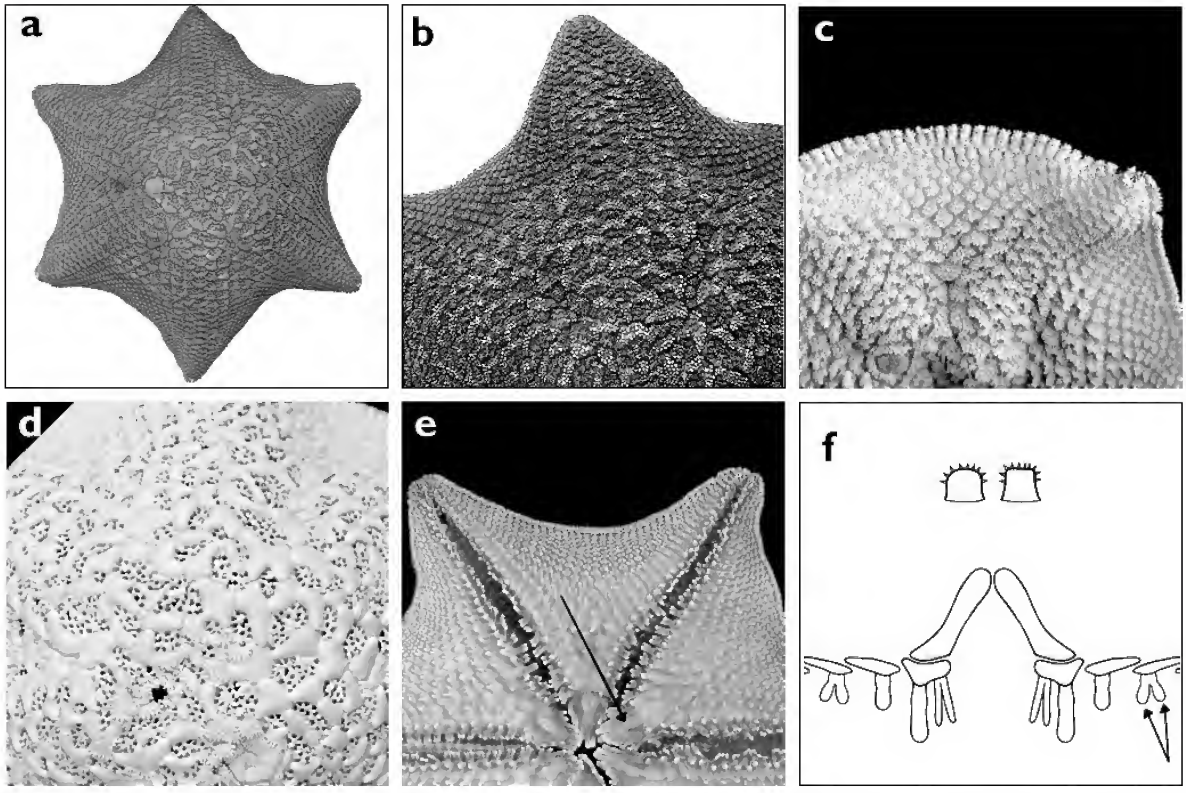

Figure 3. a–f, *Patiriella gunnii* (Gray). a, abactinal view, R = 40 mm (NMV F73273); b, abactinal ray, carinally doubly papulate for most of ray, R = 40 mm (NMV F73273); c, abactinal interradius with coarse spination and fringe of stout inferomarginal spinelets, R = 22 mm (WAM Z8948); d, cleared abactinal view, with numerous papulae and secondary plates, R = 35 mm (WAM Z8952); e, actinal ambulacra and interradius, lacking suboral spines (arrow), R = 40 mm (NMV F73273); f (above), common forms of abactinal spinelets; f (below), common forms of actinal spines proximal to ambulacrum, with very short interradial spines (arrow).

abactinal spinelets small and fine; frequent presence of some sub-oral spines; adradial row of actinal interradial spines up to about two-thirds the length of subambulacral spines; actinal interradial spines short, thin. The limited live colour data available for confirmed determinations indicates that maroon red is a common abactinal overall colour, with no reports of grey or blue or a black disc.

Patiriella occidens sp. nov.

Figures 1 (as 'western'), 5a–f, 7d

Patiriella gunnii W.—Hart et al., 1997: 1848–1861, figs 1–4, tabs 1, 2.—Byrne et al., 1999: 188–194, figs 1, 3D, 6 (non *Patiriella gunnii* (Gray, 1840)).

Material examined. Holotype. Western Australia, Perth, Cottesloe, on reef amongst algae, 1 m, L. Marsh, 29 Dec 2001, WAM Z8951 (MOL 151).

Paratypes. Type locality and date, NMV F92971 (1, cleared) (MOL 150); Albany, Cape Vancouver, Quaranup, amongst boulders, 1 m, L. Marsh, 13 Dec 2001, WAM Z8949 (1) (MOL 148); under boulder, 1 m, WAM Z8950 (1) (MOL 149); Cockburn Sound, Woodman Point, under rocks, 1 m, L. Marsh, 1 Jan 2002, WAM Z8953 (3) (MOL 154–156).

Other material (selected for molecular confirmation, distribution and depth data). **Vic.** Port Fairy, causeway beach, NMV F73149 (1). **SA.** Victor Harbour, The Bluff wharf, NMV F92975 (1) (MOL 67); Cape Jervis, rocky shallows, NMV F74638 (1) (MOL 182); Kangaroo I., Eastern Cove, rocky shallows, NMV F71862 (2) (MOL 181); Gulf Saint Vincent, Glenelg, SAM K1932 (3); Yorke Peninsula, Edithburg, 0–4 m, SAM K1904 (3); Sir Joseph Banks Group, 0–1 m, SAM K1899 (2); Eyre Peninsula, Point Labatt, 0–1 m, SAM K1907 (1); Nuyts Archipelago, 14 m, SAM K1898 (2). **WA.** E of Hopetoun, Mason Bay, East Mason Point, granite/dolerite with algae and seagrass, 0–3 m, WAM Z9470 (1); Cheyne Bay, under stones, WAM Z9479 (6); Two Peoples Bay, WAM Z9576 (2); Albany, Middleton Beach, under rocks, WAM Z9478 (2); Torbay, Mutton Bird I., under boulders, intertidal, WAM Z9474 (2); Kilkarnup, Cape Mentelle, WAM Z9466 (1); Cowaramup Bay, under boulders, 0–1 m, WAM Z9400 (1); Yallingup, limestone reef, under boulders with *P. 'brevispina'* (= *P. gunnii* here), WAM Z9396 (4); Cape Naturaliste, under intertidal granite boulders, WAM Z9405 (2); Geographe Bay, Dunsborough, WAM Z9402 (1); Rockingham, Point Peron, H.L. Clark, Oct

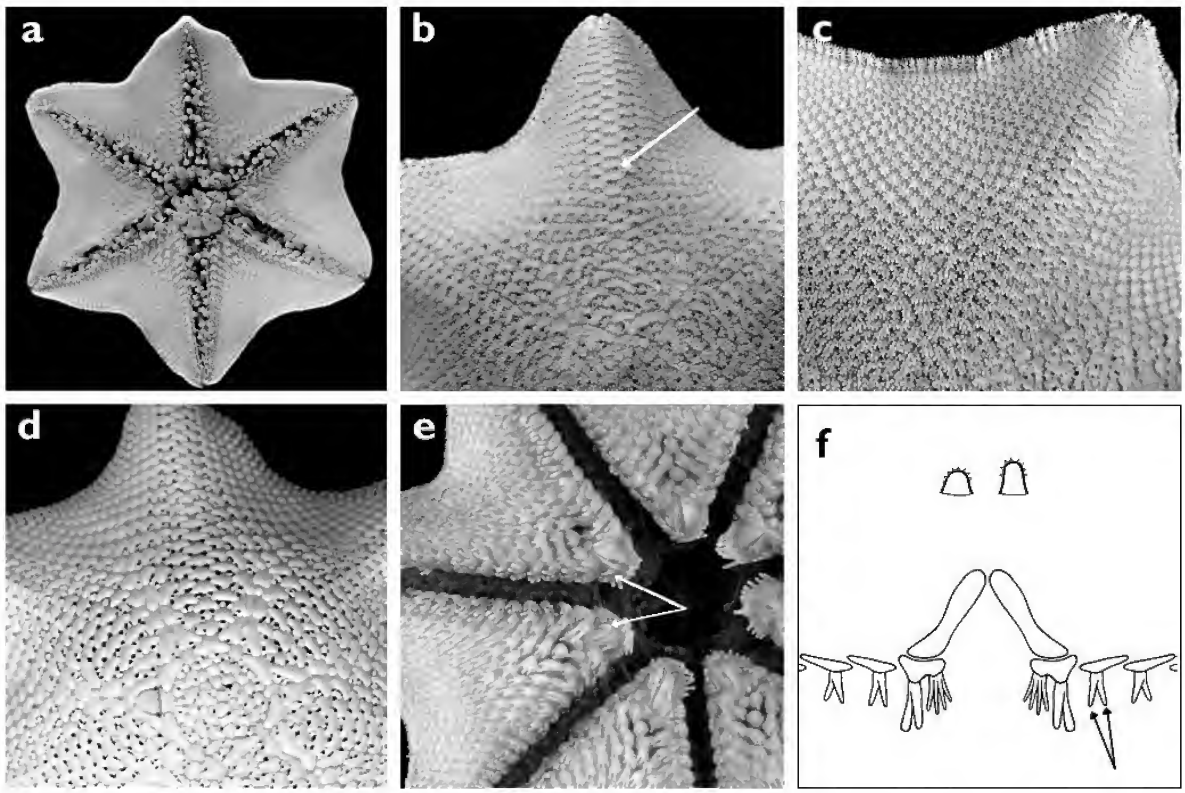

Figure 4. a–f, *Patiriella medius* sp. nov. a, actinal view of holotype, R = 25 mm (NMV F92986); b, abactinal ray of paratype, carinally doubly papulate for about half ray length (ending at arrow), R = 23 mm (NMV F92988); c, abactinal interradius of paratype, with fine spination and fringe of fine inferomarginal spinelets, R = 24 mm (NMV F92988); d, cleared abactinal view of paratype, with few papulae and secondary plates, and carinal plates doubly papulate for about half the ray length, R = 22 mm (NMV F92988); e, actinal ambulacra and interradii of paratype, with suboral spines (arrows), and atypically 7 ambulacra, R = 23 mm (NMV F92988); f (above), common forms of abactinal spinelets; f (below), common forms of actinal spines proximal to ambulacrum, with adradial actinal spines (arrow) much shorter than subambulacral spines.

1929, WAM Z9440-2 (3); SAM K712 (3); Rottnest I., reef, WAM Z9530 (9); Trigg I., reef platform, WAM Z9454 (1); Yanchep, reef, WAM Z9433 (1); Port Gregory, N of Geraldton, top of reef in pool, NMV F73179 (1); Kalbarri (Murchison River), reef top, WAM Z9413 (2).

Description (dry and cleared specimens). Up to R = 38 mm; 4–9 rays, predominantly 6 (292 of 331 AM, SAM, TM and WAM specimens with 6 rays, 25 with 7 rays, 9 with 8 rays, 3 with 5 rays, 1 with 4 rays, 1 with 9 rays); form variable from 6 distinct pointed rays with interradial margin deeply incurved (common for larger specimens) to subhexagonal (rare except for smaller specimens); body flat orally, flattened dome aborally, acute angle at margin; madreporite conspicuous; lacking pedicellariae; gonopores abactinal.

Abactinal surface slightly uneven; papulate areas more extensive than non-papulate areas; secondary plates numerous, very irregular in size and form; proximal radial and interradial plates fairly openly imbricate; proximal papular spaces fairly large, frequently 2–6 secondary plates and 6–7 papulae in proximal papular spaces outside disc when R = 30 mm (2–4 secondary plates and 4–6 papulae when R = 20 mm); abactinal plates crescentic in papulate areas, carinally with double notch and proximal lobe; carinal series frequently regular from close to disc to end or near end of rays, doubly papulate for at least three quarters ray length when R = 20 mm and larger; distal interradial non-papulate plates closely imbricate, domed, rounded proximally; disc variably distinct, bordering plates variably regular crescentic radial plates and smaller interradial plates, disc frequently obscured by irregular large plates within and distal to disc; abactinal plates granular, covered by glassy convexities, lacking spine-bearing ridge; abactinal spinelets frequently twice as long as wide, variable form, most frequently columnar, sometimes slightly widened or narrowing distally, sometimes with slight waist, truncate and prominently spinous distally, typically up to 0.48 mm long when R = 30 mm (0.36 mm when R = 20 mm), distributed over projecting surface of plates; superomarginal plates aligned longitudinally with inferomarginal plates; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

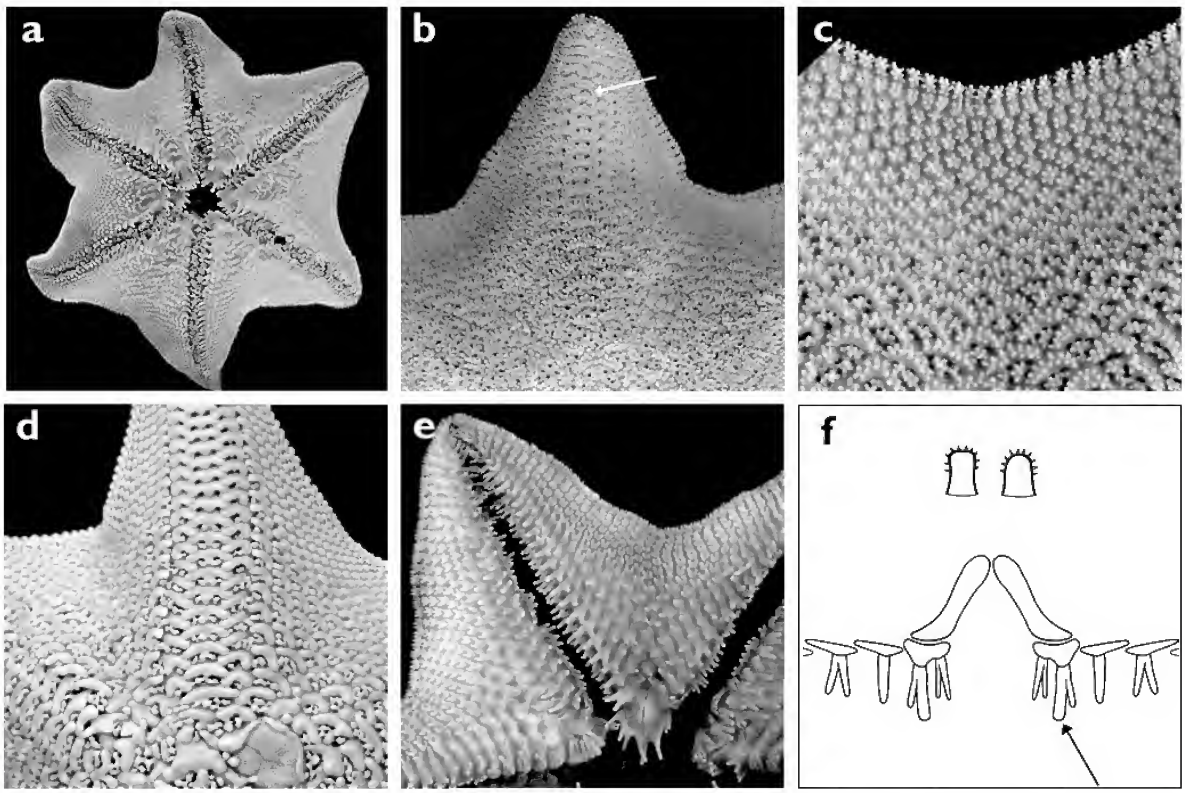

Figure 5. a–f, *Patiriella occidens* sp. nov. a, actinal view of holotype, with distinctively elongate rays, R = 35 mm (WAM Z8951); b, abactinal ray, carinally doubly papulate for most of ray (ending at arrow), and coarse cover of abactinal spinelets, R = 25 mm (WAM Z9491); c, abactinal interradius with coarse spination and fringe of stout inferomarginal spinelets, up to 10 per plate, R = 30 mm (WAM Z9483); d, cleared abactinal view of paratype, with carinal plates doubly papulate for all of ray shown, R = 31 mm (NMV F92971); e, actinal ambulacra and interradii, with oral plates lacking suboral spines, R = 25 mm (WAM Z9491); f (above), common forms of abactinal spinelets; f (below), common forms of actinal spines proximal to ambulacrum, with projecting subambulacral spines (arrow).

Projecting inferomarginal plates form margin, frequently 8–11 spinelets per plate when R = 20–30 mm; actinal plates in regular series, curving acutely from furrow to margin, some proximal actinal areas not calcified; actinal interradial spines generally thick, long, digitate, distally spinous; actinal interradial proximal plates with 1–2 spines, distally 2 (rarely 3) shorter, digitate to slightly bulbous, distally spinous spines; adradial row of actinal interradial proximal plates with predominantly 1 thick digitate spine, rarely 2, typically about four fifths length of subambulacral spines, some slightly bulbous; adambulacral proximal plates with 1–3, predominantly 2, thick subambulacral spines, frequently unequal, form variable from digitate to slightly bulbous to subcapitate to spatulate to widending distally, minutely spinous distally; furrow spines slender, tapering, webbed, 2–4 per plate proximally, predominantly 3, minutely spinous distally, subequal in length with subambulacral spines; suboral spines rare (at least 1 suboral spine on 23 of 307 AM, SAM, TM and WAM specimens examined; more than 10 suborals on 2 of 307); oral spines 4–6, predominantly 5.

Live colour. Very variable abactinally; commonly dark coloured disc, sometimes red; frequently grey appearance; sometimes fairly uniform grey or red or blue-green or grey-blue or blue or brown or orange, sometimes with black or white flecks; some with rays, interradii and margin coloured differently, or with colour patches; frequently mottled with grey, white, green, red, brown, blue, orange, mauve, black.

Distribution. Port Fairy (Vic.) continuous to Kalbarri (WA); predominantly on reef flat, sometimes with seagrass; 0–14 m (molecular confirmation for Victor Harbour (SA) to Perth (WA)).

Etymology. From *occidens* (Latin, as a noun in apposition) meaning "west" and referring to the westerly distribution in southern Australia.

Remarks. Hart et al. (1997) and Byrne et al. (1999) found from molecular evidence that specimens of *Patiriella 'gunnii'* from eastern and western Australia had divergent lineages. The western material was collected from Margaret River in WA (L. Marsh, pers. comm.). Western Australian specimens are

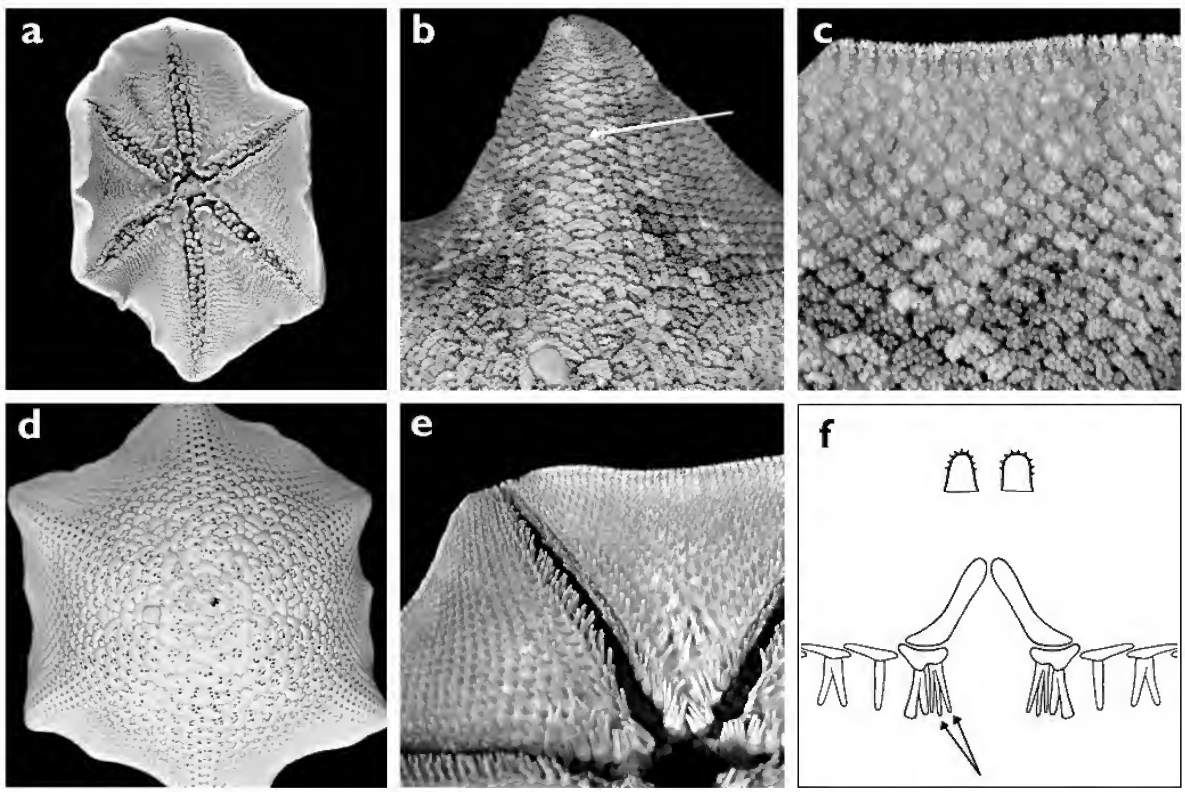

Figure 6. a–f, *Patiriella oriens* sp. nov. a, actinal view of holotype, R = 28 mm (NMV F92983); b, abactinal ray, carinally doubly papulate for about two-thirds of ray length (ending at arrow), R = 25 mm (NMV F73152); c, abactinal interradius with moderately coarse spination and fringe of fairly fine inferomarginal spinelets, up to 15 per plate, R = 25 mm (NMV F73152); d, cleared abactinal view of paratype, with carinal series doubly papulate for most of ray length, R = 25 mm (NMV F92984); e, actinal ambulacra and interradii, R = 30 mm (NMV F73155); f (above), common forms of abactinal spinelets; f (below), common forms of actinal spines proximal to ambulacrum, with relatively long furrow spines (arrow).

confirmed by molecular and morphological evidence and described here as *Patiriella occidens* sp. nov.

Grice and Lethbridge (1988) reported on the reproductive and developmental biology of *Patiriella 'gunnii'*. Since the research was based on material collected from the region of Perth, it is assumed here that the species was not *P. gunnii* but probably the readily found and collected new species *P. occidens* (used hereafter for *P. 'gunnii'* from western Australia). It is improbable that the collections included the cryptic *P. medius*, which is sympatric with *P. occidens* in the Perth region. Grice and Lethbridge (1988) found that spawning by *P. occidens* occurred in late summer and early autumn. Spawning is thus later than *P. oriens* (see below), a factor which may be significant in the maintenance of genetic identity in these similar species. *P. occidens* is found most frequently on intertidal reef platform, a habitat frequently occupied by *P. calcar*. This potential competitive factor may have resulted in the absence of *P. calcar* in most of the distribution range of *P. occidens*.

The combination of morphological characters which distinguishes *P. occidens* from other six-rayed *Patiriella* species is: frequently distinct long rays; carinal series of plates frequently doubly papulate for at least three-quarters ray length; abactinal spinelets frequently columnar, distally slightly swollen and spinous, and creating a very coarsely spinous surface appearance; normal absence of suboral spines; subambulacral spines projecting significantly above furrow and actinal interradial spines; actinal interradial spines digitate; up to about 11 spinelets per inferomarginal plate. The limited live colour data available for confirmed determinations indicates that grey or brown or blue are frequently evident abactinally, and red infrequently.

Patiriella oriens sp. nov.

Figures 1 (as 'eastern'), 6a–f, 7e

Patiriella gunnii E.—Hart et al., 1997: 1848–1861, figs 1–4, tabs 1, 2.—Byrne et al., 1999: 188–194, figs 1, 3D, 6 (non *Patiriella gunnii* (Gray, 1840)).

Material examined. Holotype. Tasmania, Recherche Bay, Black Reef, 8 m, N. Barrett, 6 Jun 2002, NMV F92983 (MOL 193).

Paratypes. Type locality and date, NMV F92984 (1 dry, 1 cleared)

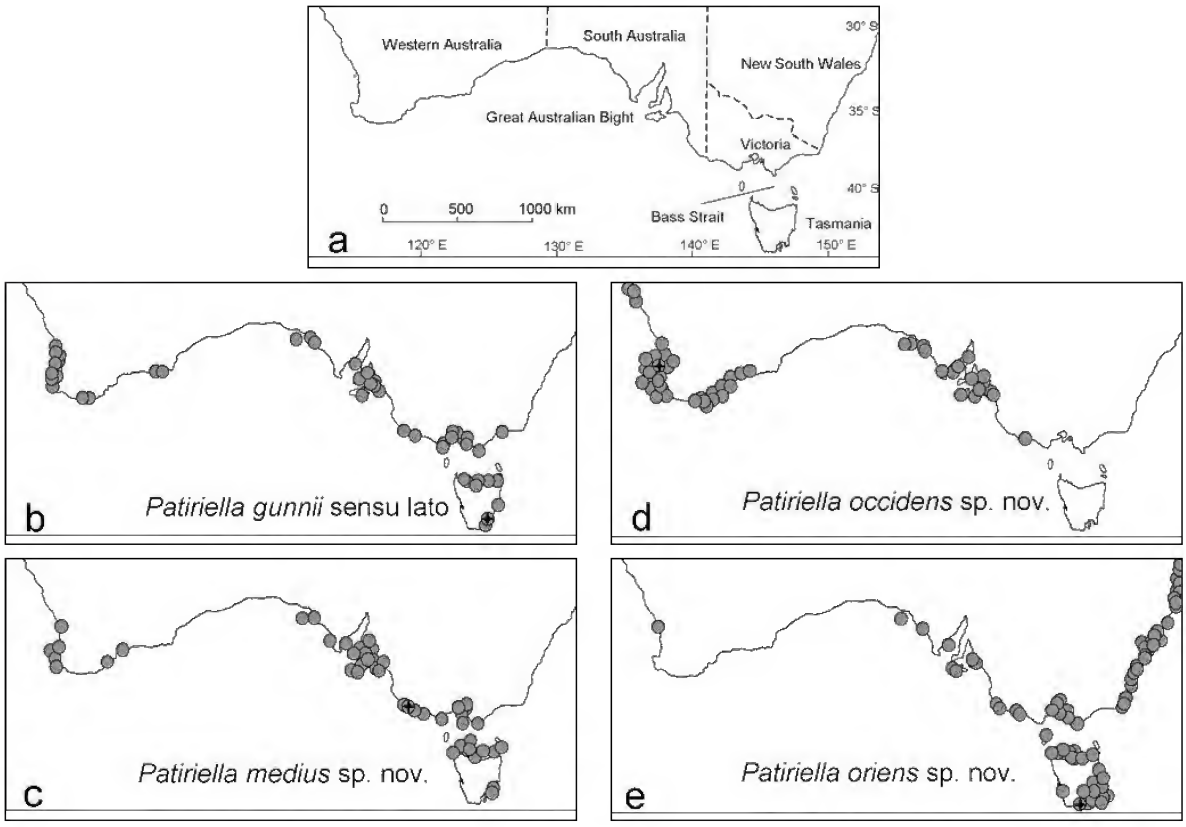

Figure 7. a, the temperate region of southern Australia.

b–e, geographic distributions based on morphological determinations, with type localities for each of the species indicated by crossed symbols; b, *P. gunnii* sensu lato; c, *P. medius* sp. nov.; d, *P. occidens* sp. nov.; e, *P. oriens* sp. nov.

(MOL 191, 192); Bicheno, rocky coast, 5 m, N. Barrett, 1 Apr 2002, NMV F92982 (6) (MOL 201–203, 205).

Other material (selected for molecular confirmation, distribution and depth data). Lord Howe I., AM J19339 (1). **Qld.** Rockhampton, Satellite I., 6 m, NMV F73165 (1). **NSW.** Byron Bay, Julian Rocks, 12 m, AM J14869 (1); Minnie Water, AM J12953 (26); Wooli, AM J15570 (6); Woolgoola, North Solitary I., 30 m, AM J14910 (4); Coffs Harbour, Solitary I., 9 m, AM J14942 (13); South Solitary I., 27 m, AM J14899 (1); Broughton I., near Port Stephens, 25 m, AM J12963 (3); Wyong, Nora Head, WAM Z9382 (1); Manly, Long Reef, SAM K1909 (18); Port Jackson, Camp Cove, AM J20059 (1); Swansea Channel, near Heads, 3 m, AM J21893 (4); Clovelly, NMV F93180 (9) (MOL 215, 218, 219, 220); Little Bay, AM J4794 (5); Shellharbour, rock pools, AM J4419 (15); Jervis Bay, under rocks, 25 m, AM J15610 (1); Ulladulla, 24 m, AM J14179 (1); Batemans Bay, 12 km S, Pretty Point Bay, rocky shallows, NMV F71858 (1, cleared) (MOL 184); Montague I., 27–30 m, AM J13972 (1); Merimbula, rocky, 9 m, AM J14651 (2); Eden, Twofold Bay, sublittoral platform, AM J19853 (2). **Vic.** Walkerville South, NMV F93448 (2); Western Port, McHaffie Point, NMV F93175 (1); Flinders, ocean platforms, 0–2 m, NMVF92979 (1) (MOL 175); NMV F92985 (2) (MOL 2); NMV F92980 (1) (MOL 5); NMV F92981 (2) (MOL 116, 117); Port Phillip Bay, Portsea jetty; under rubble, 4–5 m, NMV F73200 (1); Torquay, Point Danger, rocky shallows, NMV F92976 (1, cleared) (MOL 65); Port Fairy, Griffith I., rocky shallows, NMV F92978 (3) (MOL 77, 78, 80); NMV F92977 (1, cleared) (MOL 71); Portland, Nelson Bay, 24 m, NMV F93462 (4). **Tas.** Cape Tourville, rocky shallows, NMV F71870 (3); Maria I., 10 m, TM H1792 (1); Forestier Peninsula, 4–9 m, SAM K1911 (4); Eaglehawk Neck, TM H1109 (2); Hobart, Tinderbox, under rocks, 2 m, NMV F73993 (2); Port Davey, Sarah I., 3 m, TM H1789 (4); Bass Strait, Ringarooma Bay, TM H1114 (5); Tamar River, Low Head, TM H1352 (1); Circular Head, TM H1765 (34); King I., Narracoopa, NMV F93447 (1). **SA.** Encounter Bay, 2–4 m, SAM K1919 (1); Kangaroo I., Western River, 10–12 m, SAM K1915 (1); Spencer Gulf, Gambier Is, Wedge I., under stones, 1–1.5 m, AM J23763 (2); Nuyts Archipelago, 6 m, SAM K1937 (1). **WA.** Perth, Cottesloe, beach after storm, TM H2945 (1).

Description (dry and cleared specimens). Up to R = 39 mm; 4–8 rays, predominantly 6 (373 of 396 AM, SAM and TM specimens with 6 rays, 18 with 7 rays, 3 with 5 rays, 1 with 4 rays, 1 with 8 rays); form variable, from 6 short pointed to rounded rays with interradial margin incurved, to subhexagonal; body flat orally, flattened dome aborally, acute angle at margin; madreporite conspicuous; lacking pedicellariae; gonopores abactinal.

Abactinal surface even; papulate areas more extensive than non-papulate areas; secondary plates numerous, very irregular in size and form; proximal radial and interradial plates fairly openly imbricate; proximal papular spaces fairly large, frequently 3–5 secondary plates and 4–6 papulae in proximal papular spaces outside disc when R = 30 mm (2–4 secondary plates and 4–5 papulae when R = 20 mm); abactinal plates crescentic in papulate areas, carinally with double notch and proximal lobe; carinal series frequently regular from close to disc to end or near end of rays, doubly papulate for more than half up to three quarters ray length when R = 20 mm and larger; distal interradial non-papulate plates closely imbricate, domed, rounded proximally; disc variably distinct, bordering plates variably regular crescentic radial and smaller interradial plates, disc frequently obscured by irregular large plates within and distal to disc; abactinal plates granular, covered by glassy convexities, lacking spine-bearing ridge; abactinal spinelets slightly less than twice as long as wide, variable form, not widened distally, most frequently with swollen base and narrowing distally, sometimes columnar, sometimes with slight waist, rounded with small spines distally, typically up to 0.44 mm long when R = 30 mm (0.34 mm long when R = 20 mm), distributed evenly over projecting surface of plates; superomarginal plates aligned distally with inferomarginal plates; lacking internal superambulacral plates between ambulacrals and actinals; distal abactinal and actinal interradial plates with internal tapered vertical contiguous projections.

Projecting inferomarginal plates form margin, frequently 10–15 spinelets per plate when R = 20–30 mm; actinal plates in regular series, curving acutely from furrow to margin; some proximal actinal areas not calcified; actinal interradial spines generally fairly thick, digitate, moderately tall; actinal interradial proximal plates with 1–3 slightly tapered spines, predominantly 1, distally 3–4 short thick spines, columnar to slightly tapered, spinous distally; adradial row of actinal interradial proximal plates with predominantly 1–2 thick spines, minutely spinous distally, slightly shorter than subambulacral spines; adambulacral proximal plates with 1–3, predominantly 2, thick subambulacral spines, frequently unequal, form variable from digitate to spatulate to widening distally, minutely spinous distally, frequently slightly shorter than furrow spines; furrow spines slender, tapering, webbed, minutely spinous distally, 2–4 per plate proximally, frequently slightly longer than subambulacral spines; suboral spines very rare (9 of 273 AM speciems with at least 1 suboral spines, 1 with 7 spines, 1 with 9 spines, 1 with 11 spines); oral spines 4–6, predominantly 5.

Live colour. Abactinally very variable; frequently pale or light coloured; commonly dark coloured disc; some fairly uniform white or pink or mauve or orange or bright red, sometimes with dark red or brown or white flecks; some with rays, interradii or margin coloured differently; some finely mottled with brown, red, mauve, pink, orange, yellow, green, white (NSW specimens sometimes with grey); actinally typically off-white with rare to sparse colour flecks.

Distribution. Lord Howe I.; Rockhampton (Qld) continuous to Nuyts Archipelago (western SA); Cottesloe, Perth (WA); Bass Strait; Tas.; under rocks; 0–30 m (molecular confirmation for Batemans Bay (NSW) to Port Fairy (Vic.)).

Etymology. From *oriens* (Latin, as a noun in apposition) meaning "east", and referring to the uniquely easterly distribution in Australia.

Remarks. Hart et al. (1997) and Byrne et al. (1999) found from molecular evidence that specimens of *Patiriella 'gunnii'* from eastern and western Australia had divergent lineages. The eastern material was collected from Clovelly, Sydney (M. Byrne, pers. comm.). Eastern Australian specimens are confirmed by molecular and morphological evidence and described here as *Patiriella oriens* sp. nov. Byrne (1991, 1992, 1995, 1996), Byrne and Anderson (1994), Byrne and Cerra (1996), Cerra and Byrne (2001), and Long and Byrne (2001) reported

extensively on the reproductive and developmental biology of *Patiriella 'gunnii'*. Since this research was based on material collected from Clovelly (M. Byrne, pers. comm.), the species was not *P. gunnii* but the new species *P. oriens* (used hereafter for *P. 'gunnii'* from Clovelly).

Byrne (1992) reported broadcast spawning during spring and summer and some habitat overlap for Clovelly populations of *P. oriens* (typically under subtidal boulders) and *P. calcar* (typically intertidal reef). Byrne and Anderson (1994) subsequently reported viable laboratory hybrids (high frequency of seven rays) of *P. oriens* (typically six rays) and *P. calcar* (typically eight rays). Field and museum specimens of *P. oriens* observed by Byrne and Anderson (1994), and material seen in this study, showed a low frequency of seven rays, suggesting variation of arm number (within the species) or hybridization or both. Relevant to this consideration is the fact that about 10% of specimens of *P. occidens* (above) have more than six arms across a distribution range where *P. calcar* is mostly absent. The spawning of *P. oriens* is earlier (spring and summer) than *P. occidens* (late summer, discussed above), a factor which may be significant in the maintenance of genetic identity in these similar species.

In this study a single specimen (TM H2945) which was collected on a beach at Cottesloe (Perth) after a storm was identified as *P. oriens*. It is the only specimen in Australian museums, determined as *P. oriens*, which has been collected west of Nuyts Archipelago.

The combination of morphological characters which distinguishes *P. oriens* from other species of six-rayed *Patiriella* is: frequently subhexagonal form; carinal series of plates frequently doubly papulate for about two-thirds ray length; abactinal spinelets frequently columnar and moderately spinous distally, creating a fairly coarsely spinous surface appearance; normal absence of suboral spines; furrow spines frequently slightly longer than subambulacral spines; actinal spines continuous in declining height with subambulacral spines; actinal interradial spines digitate; up to about 15 spinelets per inferomarginal plate. The limited live colour data available for confirmed determinations indicates that white or pink or mauve or orange or bright red, with a dark centre, are frequently evident abactinally.

Discussion

Byrne et al. (1999) concluded that "*P. gunnii* from eastern and western Australia are different species, while *P. brevispina* from eastern and western Australia are the same species". These conclusions were premature as they were based on relative levels of mtDNA divergence rather than any direct assessment of reproductive isolation (biological species concept, Dobzhansky, 1937; Mayr, 1942), or monophyly (phylogenetic species concept, Cracraft, 1983). Nevertheless, Byrne et al. (1999) were correct that multiple species are present: independent morphological and molecular data reveal consistent evidence for three new taxa. The newly recognised taxa are deeply divergent for mtDNA, but exhibit only subtle morphological differences. This discrepancy might reflect the lack of morphological novelty typically associated with the echinoderm body plan (Janies, 2001), but could also stem from rapid coalescence of mitochondrial genes relative to nuclear genes (Palumbi et al., 2001).

Although the overlapping distributions of these taxa (Fig. 7) provide compelling evidence for some form of reproductive isolation, we cannot rule out the possibility of a small degree of hybridization among some or all of the species in zones of sympatry. Future ecological and genetic studies should help elucidate the strength and nature of reproductive barriers. Parallel analyses of molecular and morphological characters represent a powerful technique for asteroid systematics (Flowers and Foltz, 2001; O'Loughlin et al., 2002).

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A new genus of Tasmanian millipedes (Diplopoda: Polydesmida: Dalodesmidae) with unusual spiracles and a mosaic distribution

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Abstract Mesibov, R. 2003. A new genus of Tasmanian millipedes (Diplopoda: Polydesmida: Dalodesmidae) with unusual spiracles and a mosaic distribution. *Memoirs of Museum Victoria* 62(2): 197–206.

Dasystigma gen. nov. is erected for *Lissodesmus margaretae* Jeekel, 1984 (type species), *D. bonhami* sp. nov., *D. huonense* sp. nov. and *D. tyleri* sp. nov. A dense cluster of hair-like structures of unknown function emerges from each spiracle in all *Dasystigma* species, and the four geographic distributions form a closely fitted mosaic.

Keywords Diplopoda, Polydesmida, Dalodesmidae, millipede, taxonomy, Australia, Tasmania

Introduction

R.M. Shelley suggested that distribution mosaics may be common in the Diplopoda. Mosaics of closely related species, here called *lineage mosaics*, are "typically characterized by large generic distributions, limited component ranges, tightly fitted parapatry patterns with limited instances of sympatry, clustering of components, and slight or minor differences between some species" (Shelley, 1990a: 23). A lineage mosaic of five parapatric and two allopatric species has been documented in the Tasmanian polydesmidan genus *Gasterogramma* (Mesibov, 2003). In the *Gasterogramma* mosaic, the components are readily distinguished by cursory examination of the male gonopods, i.e. the species differences are not "minor".

Here, I describe a group of four similar Tasmanian dalodesmids forming a closely fitted lineage mosaic. The group is also unusual in having hair-like structures of unknown function emerging from all spiracles. A new genus *Dasystigma* is erected for the group, based on *Lissodesmus margaretae* Jeekel, 1984.

As is also the case for components in North American millipede mosaics (Shelley and Whitehead, 1986; Shelley, 1990b), it is not yet known whether the four *Dasystigma* taxa recognised here are fully reproductively isolated. Although *D. margaretae* and *D. tyleri* sp. nov. have been found in sympatry in south-western Tasmania (with *D. huonense* sp. nov. known from a locality only 5 km distant), the overlap zone appears to be narrow and may be a tension zone (Key, 1982) maintained by hybridisation, i.e. isolation is incomplete. I regard the four *Dasystigma* as evolutionary species sensu Wiley (1978).

Specimens were killed and preserved in 75–80% ethanol. Preliminary drawings on graph paper were made using material cleared in 60% lactic acid and viewed at 100 or 200× magnification through an eyepiece graticule. A Philips Electroscan ESEM 2020 operated in high-vacuum mode was used to examine preserved material which had been air-dried before sputter-coating with gold. SEM images were acquired digitally.

To save space in the printed version, full details of localities, dates, collectors, specimens and registration numbers for the 202 samples examined are provided separately on the *Memoirs of Museum Victoria* website, www.museum.vic.gov.au/memoirs/. The specimen data table is also available from the author and a copy has been deposited at the QVM.

Collecting sites for all but a few of the specimens examined were estimated in the field to be within particular 100 m Universal Transverse Mercator (UTM) grid squares on 1:25000 scale maps published by the State of Tasmania. Grid squares are recorded below in 2-letter, 6-digit form, e.g. 'EN700712.' The maximum horizontal error in these estimates is likely to be less than 100 m. Latitude/longitude equivalents were calculated using GeoCalc 4.20 (GeoComp Systems, Blackburn, Victoria) and are not as precise as the UTM grid references. LGRSS transect locations (see separate specimen data table) were derived from 1:2000 survey charts made available to the QVM by the Hydro-Electric Commission, Tasmania, in 1994.

Abbreviations and codes are as follows: AM, Australian Museum, Sydney, NSW; ANIC, Australian National Insect Collection, Canberra, ACT; LTV. Latrobe University, Bundoora; LGRSS, Lower Gordon R. Scientific Survey, 1976–1978; NMV, Museum Victoria, Melbourne, Vic.; NRCP, National Rainforest Conservation Program invertebrate survey, 1989–1990; PCS, posterior corner seta (a long, prominent seta arising dorsally near each posterior corner of the collum and all tergites); QVM, Queen Victoria Museum and Art Gallery, Launceston, Tas. Male and female refer to stadium 8 adults.

Order **Polydesmida** Leach, 1815

Suborder **Dalodesmidea** Hoffman, 1977

Dalodesmidae Cook, 1896

Dasystigma gen. nov.

Type species. Lissodesmus margaretae Jeekel, 1984, by present designation.

Diagnosis. Differs from *Lissodesmus* and other known Australian dalodesmids in (a) the dense brush of hair-like structures emerging from each spiracle and (b) the unusually wide separation between the bases of the solenomerite and tibiotarsus on the gonopod telopodite.

Description of males. Adult length 18–22 mm when contracted in alcohol, diameter of midbody metazonite c. 1.8 mm. Overall colour pale yellow-brown to deep chestnut brown. Head with labrum weakly emarginate in center; clypeus very weakly convex in lateral view, moderately setose; vertex bare, strongly convex in lateral view, vertigial sulcus extending forward to a point about one antennal socket width from an imaginary line joining socket centres. Antennal sockets separated by about twice the diameter of a socket, weakly impressed; antennomeres (Fig. 2) setose, more densely and finely so on 5–8, antennomere lengths decreasing in the order 2, (3, 6), (5, 4), antennomere 6 the widest. Collum slightly wider than head in front, widening posteriorly, anterior margin broadly convex, lateral margin with typically 3 small, seta-bearing teeth, posterior corner rounded and not projecting, posterior margin squarely transverse laterally but with the central third slightly emarginate; several transverse rows of sparse, long setae anteriorly on collum; a long seta extending posteriolaterally from point near posterior corner of collum (= posterior corner seta, PCS). Paranota inflated (Fig. 2), maximum width at about one-third the ring diameter from the dorsum in midbody segments. Somites 2–4 from above about equal in width and slightly wider than collum; somites 5–17 about equal in width and slightly wider than 2–4; somite 18 narrower than 17. Tergites unsculptured, bare apart from PCS near posterior corners (Fig. 3). Paranota on most somites with 4 or 5 (3–6) small marginal teeth, each bearing a seta (Fig. 3); paranotal margin a straight line in lateral view, rising posteriorly; margin in dorsal view either nearly straight (parallel to long body axis) or slightly convex (see also "Derwent form" under *D. margaretae* (Jeekel, 1984) comb. nov., below); posterior corner variably projected (Fig. 3), with minute terminal seta. Ozopores on somites 5, 7, 9, 10, 12, 13, 15–19; pore opening dorsally on paranotum, just mesal to marginal thickening and typically about one-fourth of lateral margin length from tip of posterior corner. Spiracles (Fig. 5) variably enlarged, all with hair-like structures variably emergent (Fig. 1A) (at low magnification, the swollen, "hairy" spiracles in *D. bonhami* and *D. margaretae* resemble ectoparasitic mites). Legs (Fig. 2) incrassate, much more so anteriorly beginning with leg-pair 3, prefemur and femur dorsally swollen, tibia on anterior legs in *D. bonhami*, *D. margaretae* and *D. tyleri* with slight ventrodistal swelling; tarsus about as long as or slightly longer than femur; dense pubescence ventrally on coxa, prefemur, femur and postfemur; numerous sphaerotrichomes ventrally on postfemur, tibia and tarsus; long, prominent seta at ventrodistal end of coxa and prefemur and at dorsodistal end of tibia. Genital opening inconspicuous on

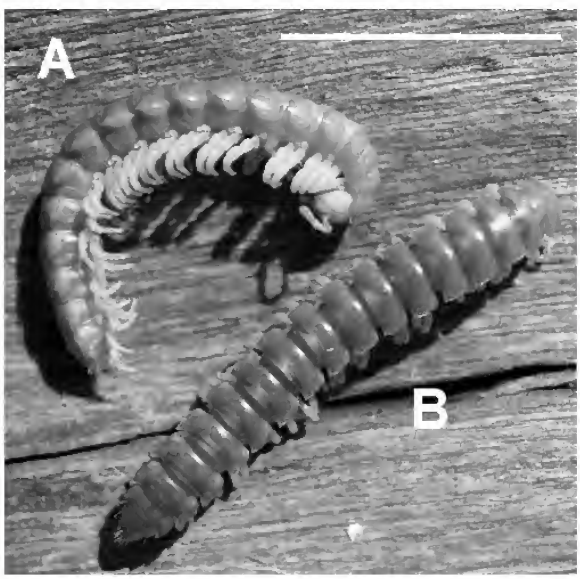

Figure 1. Whole-animal view of *Dasystigma margaretae* (Jeekel, 1984) comb. nov. A, Rocka Rivulet male, QVM 23:24949; B, Tiger Creek male, QVM 23:24950. Scale bar = 10 mm.

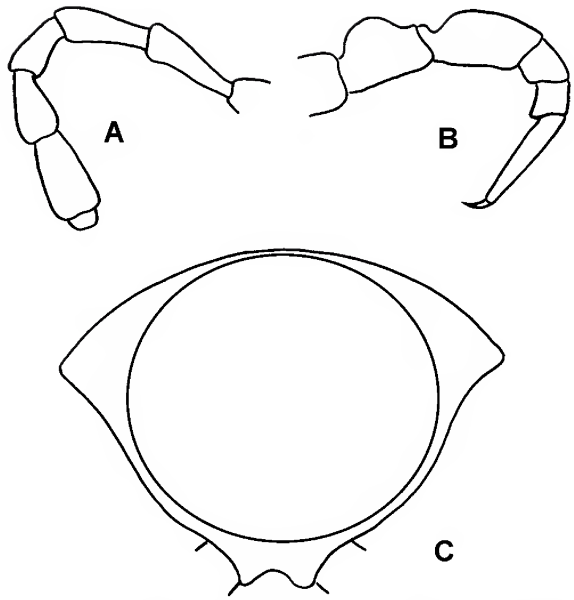

Figure 2. *Dasystigma bonhami* sp. nov., Sandspit R. male, QVM 23:15219. A, Antenna; B, leg 10; C, cross-section of somite 8. Setation not shown.

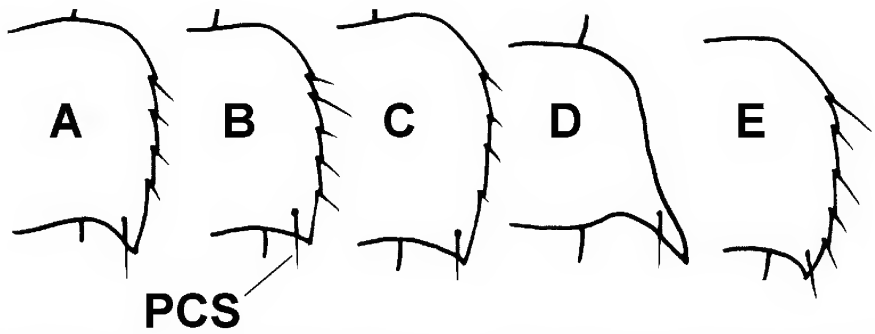

Figure 3. Dorsal views of right margin of tergite 14 of *Dasystigma* females. A, *D. bonhami* sp. nov., Sand R., QVM 23:40811; B, D. *huonense* sp. nov., Edwards Rd, QVM 23:15269; C, *D. margaretae* (Jeekel, 1984) comb. nov., Fingal Tier, QVM 23:15230; D, *D. margaretae* (Jeekel, 1984) comb. nov., Tarraleah, QVM 23:15252; E, *D. tyleri* sp. nov., Trackham Creek, QVM 23:15260. PCS = posterior corner seta.

slight distal swelling of leg 2 coxa. Preanal ring with numerous long setae, densest dorsally; epiproct in dorsal view a truncated triangle with weakly concave sides; hypoproct broadly paraboloid in ventral view.

Gonopod aperture one-third to one-half ring 7 prozonite diameter in width, about 1.5 times as wide as long; in ventral view with straight anterior and lateral margins, posterior margin slightly curved, concave anteriorly; in lateral view anterior aperture margin not raised, lateral margin not raised or slightly convex upwards, and higher than slightly raised posterior margin.

Gonopods (Fig. 4) retracted reaching as far as leg-pair 5 bases on ring 5, solenomerites and tibiotarsi of opposing gonopods interlaced. Telopodite in posterior view more or less straight, posterior and mesal faces sparsely setose from base to about level of solenomerite origin. Solenomerite arising at about half telopodite length on anteriomesal face, just proximal to origin of prefemoral process, directed first distad and mesad, then curving caudad and distad, tapering to a sharp point from about two-thirds its length and terminating at about three-quarters length of telopodite. A thin, curved ridge of cuticle on anterior surface of telopodite appearing to extend the line of the solenomerite proximad and strengthening it at its base; prostatic groove running along anterior surface of telopodite just lateral of this ridge. Tibiotarsus arising on posterior face of telopodite at about level where prefemoral process arises, smoothly curving mesad and distad, tapering near its apex to a blunt point on the telopodite just proximal to tip of solenomerite. Prefemoral process arising about midlength on telopodite, curved (concave posteriorly) and flattened anterio-posteriorly, bearing a large uncus on posterior surface at about half its length, tip of uncus pointed caudad and mesad. Femoral process arising from lateral surface of prefemoral process proximal to uncus, variably shaped, not extending further distad than prefemoral process.

Females longer and heavier-bodied than males. Legs not swollen apart from slight dorsal swelling on prefemur and femur on anterior leg-pairs; no ventrodistal swelling of tibia; no sphaerotrichomes or ventral pubescence. Cyphopods not examined.

Juveniles considerably smaller than adults, midbody metazonite diameters c. 1 mm in stadium VII and c. 0.8 mm in stadium VI. Paranotal teeth much more prominent than in adults, spiracles generally placed as in adults (see species descriptions, below) in stadium VII, but typically well-separated in stadium VI and younger.

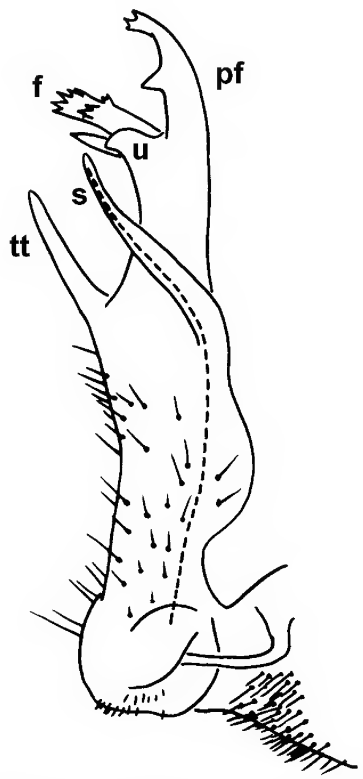

Figure 4. Mesal view of right gonopod of male holotype of *Dasystigma margaretae* (Jeekel, 1984) comb. nov., redrawn from Jeekel (1984). f = femoral process, pf = prefemoral process, s = solenomerite, tt = tibiotarsus, u = uncus. Dashed line marks path of prostatic groove.

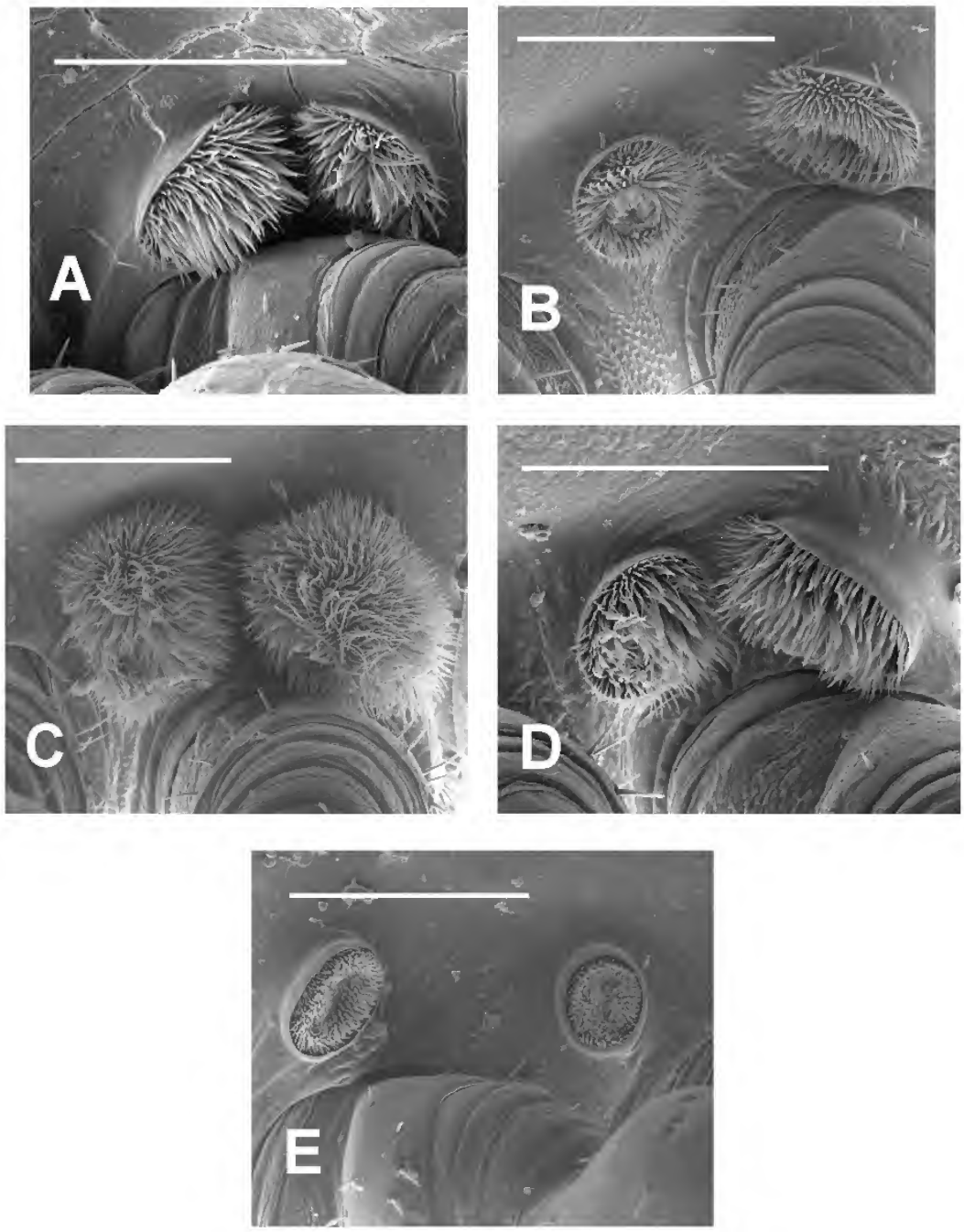

Figure 5. Spiracles on midbody segment of A, *Dasystigma bonhami* sp. nov., Sandspit R. male, QVM 23:15219; B, *D. huonense* sp. nov., Huon R. (Arve Rd) male paratype, QVM 23:40805; C, *D. margaretae* (Jeekel, 1984) comb. nov., Tooms Lake male, QVM 23:15214; D, *D. margaretae* (Jeekel, 1984), Dromedary Creek male, QVM 23:15212; E, *D. tyleri* sp. nov., White Spur male, QVM 23:15190. Scale bar in all cases = 0.25 mm; anterior to right for A–D, anterior to left for E.

Figure 6. *Dasystigma bonhami* sp. nov. Gonopods in situ. Scale bar = 0.5 mm. Flash Tier male, QVM 23:15222.

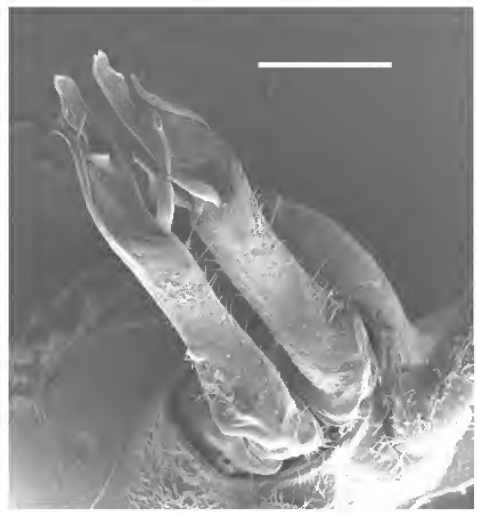

Figure 8. *Dasystigma huonense* sp. nov. Gonopods in situ. Scale bar = 0.5 mm. Picton R. male, QVM 23:40801.

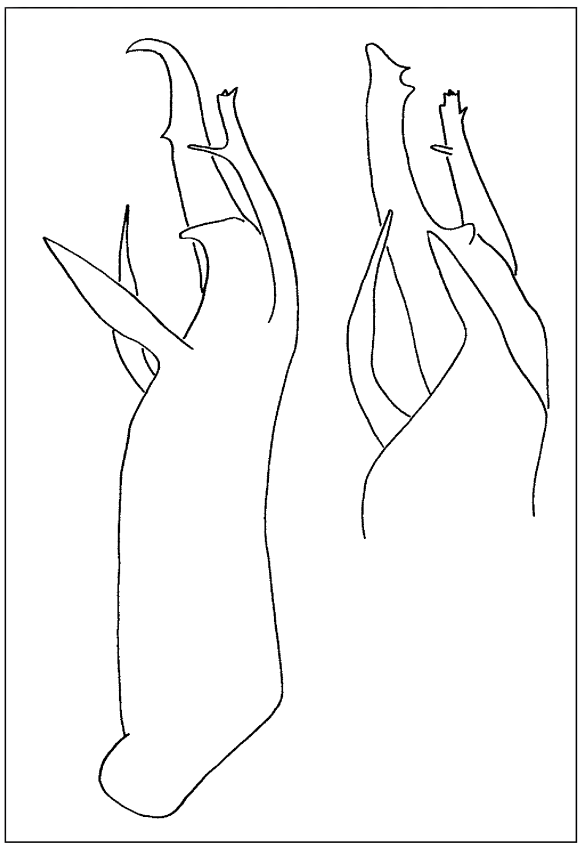

Figure 7. *Dasystigma bonhami* sp. nov. Approximately lateral (left) and mesal (right) views of left gonopod telopodite of Ravens Hill male, QVM 23:15223. Setation not shown.

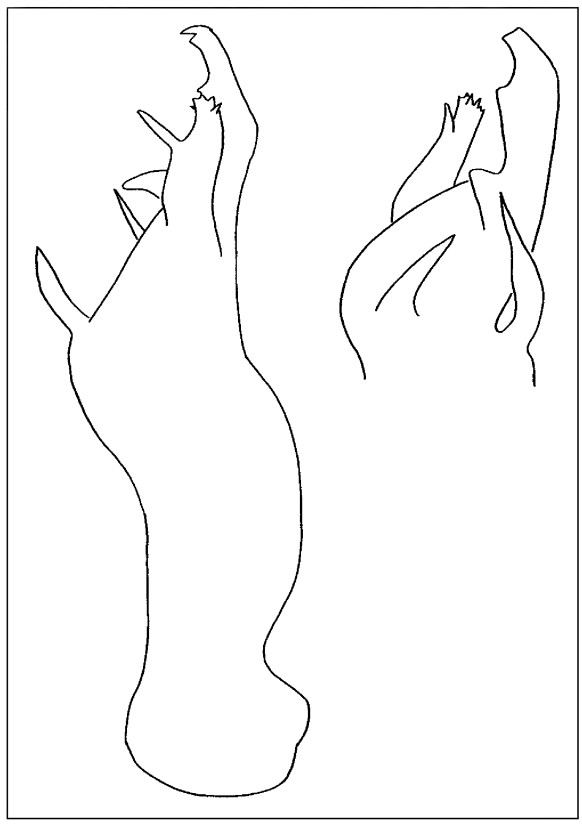

Figure 9. *Dasystigma huonense* sp. nov. Approximately lateral view (left) of left gonopod telopodite and mesal view (right) of right gonopod telopodite of Edwards Rd male paratype, QVM 23:15195. Setation not shown.

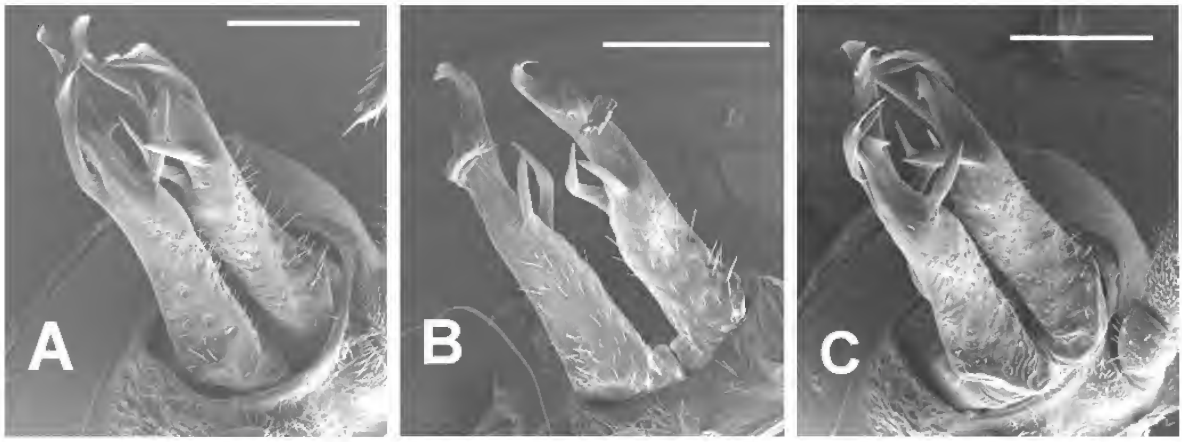

Figure 10. *Dasystigma margaretae* (Jeekel, 1984) comb. nov. Gonopods in situ, scale bar = 0.5 mm in all cases. A, Tooms Lake male, QVM 23:15214; B, Lake Augusta male paratype, (DPI-NT) 19A17; C, Coles Creek male ("Derwent form"), QVM 23:24932.

Remarks. The four species of *Dasystigma* recognised here are very similar in overall appearance (Fig. 1), distinguished partly on differences in the size, placement and "hairiness" of spiracles on diplosegments, but primarily on details of gonopod structure. The various processes on the gonopod are named here in accordance with the terminology used by Jeekel (1984) for *Lissodesmus margaretae*. Interspecific differences in gonopod structure are consistent in *Dasystigma* but subtle, and I have therefore provided for each species three different views of the gonopod, emphasising the prefemoral and femoral processes.

The dense spiracular "brush" of hairs is present in the type specimens of *D. margaretae* but appears to have been overlooked by Jeekel (1984). In 1972, P.M. Johns collected specimens of *D. bonhami* near Triabunna, in south-eastern Tasmania and later noted "spiracles greatly swollen, densely setose, the setae fine and short" (Johns, in litt., 15 Oct 1991). The function of the hair-like structures is unknown. Throughout their ranges, *Dasystigma* species co-occur in forest litter with dalodesmids of similar size and habits but with non-hairy spiracles.

Distribution and microhabitat. Tasmania south of 41°S; in and under rotting wood, in leaf litter and in humus.

Etymology. Greek *dasys* ("hairy") + *stigma* (in entomology, "opening to tracheal system"), neuter.

Dasystigma bonhami sp. nov.

Figures 2, 3A, 5A, 6, 7, 14 (map)

Material examined. Holotype. Male, Australia, Tasmania. Sandspit R., EN700712 (42°42′30″S 147°51′17″E), 230 m, 31 Jul 1991, R. Mesibov, QVM 23:41726.

Paratypes. 2 males, details as for holotype, QVM 23:15219; 1 female, details as for holotype, QVM 23:15261; 2 males, Sandspit R., EN688712 (42°42′30″S 147°50′24″E), 200 m, 26 Jun 1988, R. Mesibov, NMV K-8803, K-8804 (formerly QVM 23:15220); 2 males, Nugent, EN559711 (42°42′37″S 147°40′57″E), 400 m, 9 Aug 1998, K. Bonham and R. Crookshanks, AM KS85095 (formerly QVM 23:40807).

Other material. 30 males, 25 females and 45 juveniles from 27 unique localities including Baldy Creek, Bellettes Creek, Bishop and Clerk (Maria I.), Black Hill, Blind Creek (Maria I.), Blue Gum Spur, Carlton R., Chauncy Vale, Douglas Creek, Flash Tier, Macgregor Peak, Maclaines Creek, Mother Browns Bonnet, Mt Walter, Ravens Hill, Sand R., Sandspit R., Sheepdip Creek and Three Thumbs.

Diagnosis. Differs from other *Dasystigma* in its slender, upright femoral process with a small mesal spike, from *D. huonense* and *D. tyleri* in having posterior spiracle on diplosegments located above anterior leg, and from *D. tyleri* in having large spiracles (unusually large for dalodesmids) with much greater spiracular "hairiness."

Description. As for the genus except in the following details. Both spiracles on diplosegments (Fig. 5A) positioned over anterior leg, hair-like structures emergent from spiracles and apparent at low magnification, spiracles unusually large for a dalodesmid. Paranotal margin very slightly convex; posterior corner projected caudad (Fig. 3A). Gonopod telopodite (Figs 6, 7) with prefemoral process narrowing slightly distad, apex curving caudad, with 2 teeth on lateral edge near apex and single tooth on mesal edge more proximad. Femoral process projecting parallel to prefemoral process and terminating just proximal to flexed apex of latter. Femoral process a narrow, somewhat flattened rod with a few, minute terminal teeth, a small, slender spike arising at about three-quarters of process length and projecting mesad.

Distribution and macrohabitat. Common in dry and wet eucalypt forest over c. 2000 km^2 in south-eastern Tasmania, from Campania east to Maria I. and from the Forestier Peninsula north to the Little Swanport River valley (Fig. 14); c. 100–600 m elevation.

Etymology. In honour of the Tasmanian malacologist Kevin J. Bonham, a very talented collector whose "bycatch" of millipedes nearly always contains specimens of interest.

Remarks. D. bonhami varies little in size and form across its range. However, even syntopic adults differ considerably in the depth of dorsal body coloration, with some pale and others honey- or chestnut-coloured.

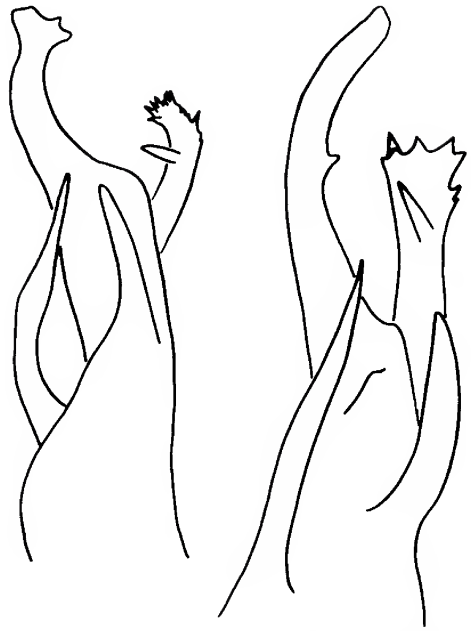

Figure 11. *Dasystigma margaretae* (Jeekel, 1984) comb. nov. Approximately mesal views of left gonopod telopodite of (left) Lake Augusta male paratype (DPI-NT) 19A17 and (right) Tarraleah male ("Derwent form"), QVM 23:15203. Setation not shown.

Dasystigma huonense sp. nov.

Figures 3B, 5B, 8, 9, 14 (map)

Material examined. Holotype. Male, Australia, Tasmania. Edwards Rd, DN797310 (43°04′23″S 146°45′02″E), 110–130 m, 15 Mar – 6 Apr 1988, R. Mesibov, QVM 23:41728.

Paratypes. 3 males, details as for holotype, QVM 23:15195; 1 male, Huon R. (Arve Rd), DN788280 (43°06′00″S 146°44′22″E), 150 m, 22 May 1997, R. Mesibov, plot 3M5, QVM 23:40805; 1 female, Huon R. (Manuka Rd), DN769286 (43°05′41″S 146°42′58″E), 100 m, 29 Apr 1997, R. Mesibov, plot 1R4, QVM 23:40800; 2 males, Coopers Creek, DN507635 (42°46′45″S 146°23′50″E), 460 m, 23 Feb 1994, R. Mesibov, AM KS85096 (formerly QVM 23:15199); 1 male, Picton Valley, DN737146 (43°13′14″S 146°40′34″E), 300 m, 15 Jul 1994, K. Michaels, pitfall collection, NMV K-8806 (formerly QVM 23:21294).

Other material. 13 males, 18 females and 18 juveniles from 22 unique localities including Collins Cap, Coopers Creek, the Huon/Picton Rivers junction, the Huon R. crossing on the Port Davey track, Lake Sydney, Mt Mangana and Mt Tobin (Bruny I.), Mystery Creek Cave environs, Palmers Lookout, Picton R., South Cape Bay, Waterfall Bay and Arve, Edwards and Manuka Rds in the vicinity of Tahune Bridge on the Huon R.

Diagnosis. Differs from other *Dasystigma* in the sinuous curve of lateral edge of prefemoral process and corresponding curvature of apposed femoral process; from *D. bonhami* and *D. margaretae* in having posterior spiracle on diplosegments located between anterior and posterior legs; from *D. tyleri* in lacking a toothed anterior margin on femoral process and in closer spacing of spiracles on diplosegments, spiracles being larger than those in *D. tyleri* (or in other dalodesmids).

Figure 12. *Dasystigma tyleri* sp. nov. Gonopods in situ. Scale bar = 0.5 mm. Wedge Inlet male, QVM 23:24953.

Description. As for the genus except in the following details. Posterior spiracle on diplosegments (Fig. 5B) between anterior and posterior leg, hair-like structures emergent from spiracles; spiracle 'hairiness' and separation of spiracles both apparent at low magnification, spiracles unusually large for a dalodesmid. Paranotal margin slightly convex; posterior corner projected caudad and slightly laterad (Fig. 3B). Gonopod telopodite (Figs 8, 9) with prefemoral process narrowing slightly distad and strongly flattened anterioposteriorly, the apex broadly rounded with a small terminal notch, mesal edge of prefemoral process straight, lateral edge sinusoidal, convex near apex with a small tooth projecting caudad. Femoral process curving mesad in parallel with concavity on lateral edge of prefemoral process, and terminating about halfway between thickened uncus and apex of prefemoral process. Femoral process flattened with a few, minute terminal teeth, a short thick spike arising at about three-quarters of process length and projecting mesad and distad.

Distribution and macrohabitat. In wet eucalypt forest and rainforest over c. 6000 km² in southern Tasmania including South Bruny I., from Tasman Peninsula south to South Cape and west to the vicinity of Lake Pedder (Fig. 14); from near sea level to c. 700 m elevation.

Etymology. After the Huon River in southern Tasmania.

Remarks. Dasystigma huonense varies very little in size and form across its range. Adult colour varies considerably, from very pale yellow-brown to deep chestnut brown.

Dasystigma margaretae (Jeekel, 1984) comb. nov.

Figures 1, 3C, 3D, 4, 5C, 5D, 10, 11, 14 (map)

Lissodesmus margaretae Jeekel, 1984: 99.

Material examined. Holotype and paratypes. Australia, Tasmania. "Lake Augusta, 25.IV.1979 [on cushion plant] 25 April 1979,

Tasmanian Department of Agriculture 19A17, holotype, 6 , 1 ♀ (fragm.), 2 juv. ♀ (19 somites), 1 juv. ♀ (18 somites) paratypes" (Jeekel, 1984: 99). When I inspected the type-containing vial in 2001, I found two cotton-plugged genitalia tubes and (under a cotton pad) a number of body fragments. The genitalia tubes contained the male holotype and the fragmented mature female paratype, respectively, both in good condition. After removing a paratype male segment 7 for SEM examination, I placed the remaining body fragments in a small cotton-plugged glass tube. The three tubes and all accompanying labels were then sealed in an alcohol-filled McCartney vial for continuing storage at the New Town Laboratories of the Tasmanian Department of Primary Industries, Water and Environment (formerly the Department of Agriculture).

Other material. 97 males, 66 females and 72 juveniles from 52 unique localities including Alberts Marsh, Anglers Creek, Blackman R., Blue Tier Creek, Boyer, Brumbys Creek, Butlers Gorge, Coal Marsh, Coles Creek, Dromedary Creek, Fingal Tier, Flexmore Creek, Florentine R., Gulf Creek, Halls Creek, Lake Dobson, Liawenee, Little Florentine R., Lookout Hill, Lost Falls, Meehan Range, Mossy Marsh Creek, Mt Mismanagement, Native Tier, Old Mans Head, Pinnacles Creek, R. Dee, Rocka Rivulet, Sassafras Hill, St Pauls Dome, Tarraleah, Tiger Creek, Tooms Lake, Tooms White Gum Reserve and Yangena Hill.

Diagnosis. Differs from *D. bonhami* in having a broader, more flexed and more prominently toothed femoral process; from *D. huonense* and *D. tyleri* in having the posterior spiracle on diplosegments located above the anterior leg; from *D. tyleri* in having much "hairier" spiracles, spiracles also being larger than those in *D. tyleri* (or in other dalodesmids).

Description. As for the genus except in the following details. Both spiracles on diplosegments (Fig. 5C) positioned over anterior leg, hair-like structures emergent from spiracles and apparent at low magnification, spiracles unusually large for a dalodesmid. Paranotal margin slightly convex; posterior corner variably projected (Figs 3C, D; see *Remarks*). Gonopod telopodite (Figs 10, 11) with prefemoral process bent mesad, sharply narrowing distad, apex curving caudad, apical edge slightly serrulate, a single tooth on mesal edge of process at about three-quarters of process length. Femoral process curving caudad and mesad and terminating just proximal to level of tooth on mesal edge of prefemoral process. Femoral process massive, divided into a broadly cuneate anterior portion and a posterior spike; distal and posterior margin of cuneate portion with numerous heavy teeth, spike crossing below cuneate portion in manner of a thumb bent slightly towards palm.

Distribution and macrohabitat. Common in dry and wet eucalypt forest and in subalpine woodland over c. 12 000 km^2 in eastern and central Tasmania (Fig. 14), from the south side of the Fingal Valley south to the north side of the Little Swanport R. valley, and from near the east coast west to the Little Florentine R.; so far known at altitudes c. 100–1100 m elevation. Locally abundant in places in the Eastern Tiers, on the eastern fringe of the Central Plateau and in wet forests in the Derwent valley.

Remarks. Jeekel (1984) gave a complete description of this species from the type locality, Lake Augusta on Tasmania's Central Plateau; for the sake of consistency I have included my own summary. This taxon is the most variable within

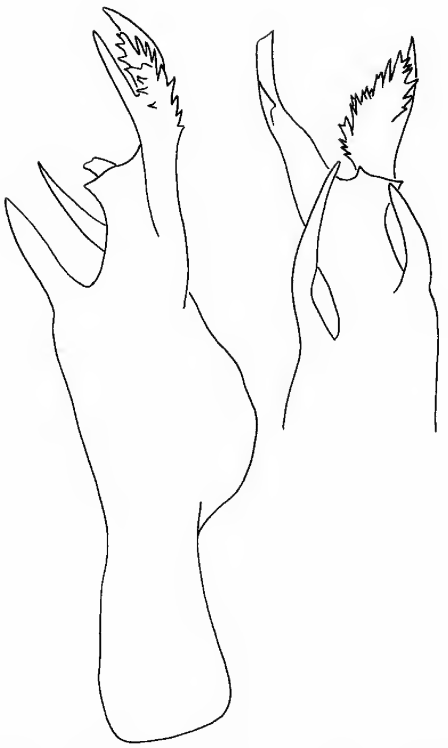

Figure 13. *Dasystigma tyleri* sp. nov. Approximately lateral (left) and mesal (right) views of left gonopod telopodite of Franklin R. male, QVM 23:15189. Setation not shown.

Dasystigma. The prefemoral process is straighter and narrower in the eastern portion of the range (Fig. 10A) than in the west (Fig. 10B) and the femoral process less bent mesad. A distinctive variant, here called the "Derwent form," is restricted to the valley of the Derwent R. (Fig. 14), where it replaces more typical *D. margaretae*. In the "Derwent form" the spiracles are somewhat less "hairy" (Fig. 5D) and the prefemoral process somewhat broader (Figs 10C, 11). The most striking difference, however, is in the form of the paranota: the margins have moved ventrad relative to those in typical *Dasystigma* and the posterior corners are very strongly projected caudad and laterad (Fig. 3D). In future, genetic data may justify the erection of a new species for this geographically and morphologically distinctive variant. I am reluctant at this time to name the "Derwent form" formally, as it differs less from more typical *D. margaretae* in gonopod details than do the three forms recognised here as new species.

Dasystigma tyleri sp. nov.

Figs 3E, 5E, 12, 13, 14 (map)

Material examined. Holotype. Male, Australia, Tasmania. Donaghys Hill, approx. DP120270 (42°12′S 145°56′), 480 m, 29 Apr 1987, N. Platnick, R. Raven and T. Churchill, QVM 23:41729.

Paratypes. 1 male, Little Florentine R., DN525683 (42°44′10″S 146°25′10″E) 440 m, 2 Dec 1986, R. Bashford, QVM 23:40796; 1

male, Trackham Creek, CQ822092 (41°27′36′′S 145°35′22′′E), 630 m, 28 Oct 1991, R. Mesibov, QVM 23:15180; 1 female, Wedge Inlet, DN379569 (42°50′16′′S 146°14′24′′E), 350 m, pitfall emptied 16 Nov 2001, D. Driscoll, sample EY4-75, QVM 23:24954.

Other material. 16 males, 4 females and 9 juveniles from 23 unique localities including Acheron Cave environs, Algonkian Mountain, Dismal Creek, Dohertys Range, Franklin R., Goderich Rd, Gordon R., Hardwood R., Hermit Hill, Laughing Jack Lagoon, Little Florentine R., Loddon R., Mt Rufus, Olga R., The Clump, Trackham Creek, Wakefield Creek, Wedge Inlet and White Spur.

Diagnosis. Differs from other *Dasystigma* in having a heavily toothed femoral process with teeth on anterior margin and small spiracles with no "hairiness" visible at low magnification, with posterior spiracle located just anterior to posterior leg on diplosegments.

Description. As for genus except in following details. Posterior spiracle on diplosegments (Fig. 5E) positioned just anterior to posterior leg and very clearly separated from anterior spiracle; hair-like structures only just emergent from spiracles, not apparent at low magnification; spiracles of size typical for dalodesmids. Paranotal margin slightly convex; posterior corner projected caudad and slightly mesad (Fig. 3E). Gonopod telopodite (Figs 12, 13) with prefemoral process narrowing sharply distad, truncated apex curving caudad and shallowly notched; on posterior surface a small tooth near apex; uncus apparently bifid, with second, caudally projected tip arising from its lateral edge. Femoral process arising in small depression on lateral surface of telopodite, projecting distad and slightly mesad. Femoral process massive, divided into broadly lanceolate anterior portion and robust posterior spike; entire margin of lanceolate portion with numerous heavy teeth, spike extending just past most distal teeth and nearly reaching as far distad as apex of prefemoral process.

Distribution and macrohabitat. An uncommon species in rainforest and wet eucalypt forest over c. 11 000 km^2 in western Tasmania, from Lake Pedder north to Balfour in a band 70–90 km wide extending inland from the west coast (Fig. 14); c. 50–1000 m elevation.

Etymology. In honour of the Australian limnologist Peter A. Tyler, whose investigations in Tasmania led to the recognition of the biogeographic divide known as Tyler's Line.

Remarks. There is little morphological variation over the *D. tyleri* range, but mature specimens tend to be somewhat larger and more heavily pigmented in northwest Tasmania than in the Southwest.

Dasystigma sp.

A number of female and juvenile specimens cannot yet be assigned with confidence to any of the named species; this unidentified material is shown as "*Dasystigma* sp." in the specimen data table and the distribution map (Fig. 14). Males from Little Quoin (Yarlington Tier) seem closest to *D. huonense*, yet this locality, an isolated forest fragment, lies between the ranges of *D. bonhami* and *D. margaretae*. The Little Quoin and Boyd R. material includes DNA vouchers in absolute ethanol, and genetic analysis can be used in future to clarify taxonomic placement.

Biogeography and conservation

Where species of *Dasystigma* are not locally abundant, they can be hard to find and it has so far not been possible to map range boundaries on as fine as scale as has been done for other Tasmanian dalodesmids (Mesibov, 1997, 1999). It seems likely, however, that the apparently narrow parapatric boundary between *D. tyleri* and *D. margaretae* in western Tasmania (Fig. 14) is congruent with Tyler's Line (Mesibov, 1994), a major biogeographic divide in Tasmania which is also commonly a species boundary for millipedes. An uncertain divide in eastern Tasmania is the one between *D. bonhami* on Forestier Peninsula and *D. huonense* on Tasman Peninsula (Fig. 14); it is not yet known whether the two species meet in parapatry on one or the other of the peninsulas, or are separated by the narrow strip of interpeninsular land (Eaglehawk Neck). Also uncertain is the gap between *D. bonhami* and *D margaretae* in the valley of the Little Swanport River. The upstream portion of the valley now carries agricultural grassland and is unsuitable *Dasystigma* habitat, and access difficulties have so far limited sampling in the woodlands on the lower portion of the river. The nearest currently known localities for *D. bonhami* and

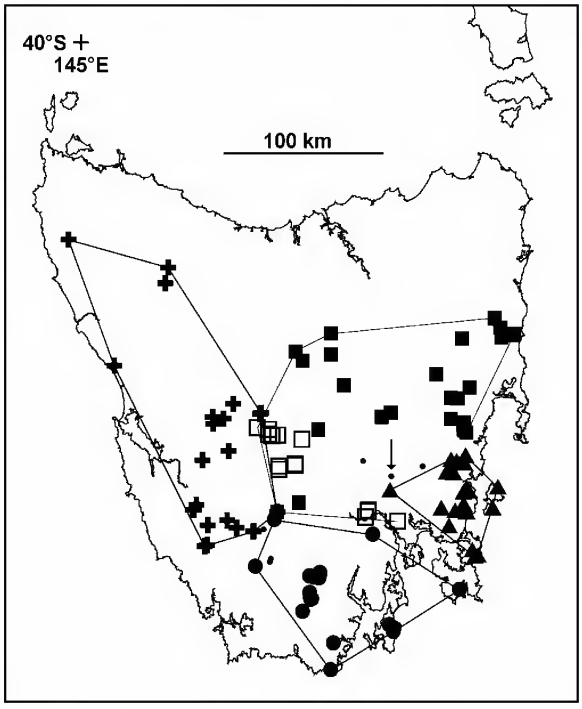

Figure 14. Known localities (to Jun 2002). *Dasystigma bonhami* sp. nov., ▲. *D. huonense* sp. nov., ●. *D. margaretae* (Jeekel, 1984) comb. nov., ■. *D.margaretae* (Jeekel, 1984) comb. nov. "Derwent form", □ *D. tyleri* sp. nov., +.Unidentified *Dasystigma* species, •. Polygons have been drawn through outermost known localities of each of the four named species to more clearly delineate the species ranges. Arrow marks Little Quoin (see text).

D margaretae are 14 km apart. About 12 km currently separates the nearest localities for *D. huonense* and *D. margaretae* ("Derwent form") across the Derwent River valley just downstream from New Norfolk. Forest in this portion of the Derwent valley has been largely cleared or degraded, and a search for evidence of *D. huonense/D. margaretae* overlap should begin much further up the Derwent system; the two species have been collected only 5 km apart just west of Maydena. Another mapping exercise for the future is documentation of the apparent parapatry (Fig. 14) between the typical and "Derwent" forms of *D. margaretae*.

Dasystigma bonhami, D. margaretae (all known variants) and *D. huonense* are often locally abundant and are found in formal State reserves. Much of the range of the less common *D. tyleri* is formally reserved, notably in national parks. The three eastern species have all been found in logged and regenerated native forest, including older regrowth (20+ years) from clearfall-and-burn operations. For evolutionary studies and for clarification of taxonomic boundaries it would be worthwhile to seek special, conservative management for public land forest patches in which different forms meet in narrow parapatry, and the author hopes to identify suitable patches in the near future.

Acknowledgements

I am grateful to the Plomley Foundation for financial assistance; to David Steele (University of Tasmania) for acquiring the SEM images; to Graeme Anderson and Owen Seeman (Department of Primary Industries, Water and Environment, Tasmania) for access to the *L. margaretae* types; to Graham Compton (CSIRO Entomology) and Dennis Black (La Trobe University) for access to ANIC material; and to Kevin Bonham and my wife Trina Moule for assistance in collecting *Dasystigma* specimens.

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The millipede genus *Gasterogramma* (Diplopoda: Polydesmida: Dalodesmidae) in Tasmania, Australia, with descriptions of seven new species

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Abstract

Mesibov, R. 2003. The millipede genus *Gasterogramma* (Diplopoda: Polydesmida: Dalodesmidae) in Tasmania, Australia, with descriptions of seven new species. *Memoirs of Museum Victoria* 60(2): 207–219.

Eight species of *Gasterogramma* (Diplopoda: Polydesmida: Dalodesmidae) occur in Tasmania: *G. austrinum* sp. nov., *G. extremum* sp. nov., *G. imber* sp. nov., *G. plomleyi* sp. nov., *G. psi* Jeekel, 1982, *G. rusticum* sp. nov., *G. tarkinense* sp. nov. and *G. wynyardense* sp. nov. The genus is largely confined to areas with an annual rainfall greater than 1000 mm. *G. psi* is widespread and abundant in the northern and western third of Tasmania, while *G. plomleyi* is restricted to the area of endemism known as Plomleys Island in Tasmania's north-east. *G. plomleyi* and the six other new species form an allopatric/parapatric distribution mosaic in northern, western and southern Tasmania. All eight species are burrowers in soil and deep litter.

Introduction

C.A.W. Jeekel (1982) established the genus *Gasterogramma* for *Gasterogramma psi* Jeekel, 1982, a peculiar Tasmanian dalodesmid millipede in which the distal portion of the gonopod telopodite appeared to Jeekel to have rotated nearly 180° in development, giving the prostatic groove a spiral path to the solenomerite. Further collections in Tasmania have yielded seven more species of *Gasterogramma*, described here. The new species strongly resemble *G. psi* in general appearance and habits and all have, like *G. psi*, a helical solenomerite, but other features of gonopod structure differ markedly from those in *G. psi*. The generic description is amended accordingly.

Specimens were killed and preserved in 75–80% ethanol. Preliminary drawings on graph paper were made using material cleared in 60% lactic acid and viewed at 100 or 200× magnification through an eyepiece graticule. A Philips Electroscan ESEM 2020 operated in high-vacuum mode was used to examine preserved material which had been air-dried before sputter-coating with gold. SEM images were acquired digitally.

More than 600 *Gasterogramma* samples were examined. To save space in the printed version, full details of localities, dates, collectors, specimens and registration numbers are provided separately on the *Memoirs of Museum Victoria* website, www.museum.vic.gov.au/memoirs/index.html. The specimen data table is also available from the author and a copy has been deposited at the QVM.

Universal Transverse Mercator (UTM) grid references are the spatial locators used by most field workers to define collecting localities in Tasmania. Collecting sites for all but a few of the specimens examined were estimated in the field to be within particular 100 m UTM grid squares on 1:25000 scale maps published by the State of Tasmania. Grid squares are recorded below in 2-letter, 6-digit form, e.g. 'EN700712.' The maximum horizontal error in these estimates is likely to be less than 100 m. Latitude/longitude equivalents were calculated using GeoCalc 4.20 (GeoComp Systems, Blackburn, Victoria) and are not as precise as the UTM grid references. LGRSS transect locations (see separate specimen data table) were derived from 1:2000 survey charts made available to the QVM by the Hydro-Electric Commission, Tasmania, in 1994.

Abbreviations are: AM, Australian Museum, Sydney; ANZSES, Australia and New Zealand Scientific Exploration Society; QVM, Queen Victoria Museum and Art Gallery, Launceston. Unless otherwise indicated, male and female refer to stadium 8 adults.

Order **Polydesmida** Leach, 1815

Suborder **Dalodesmidea** Hoffman, 1977

Dalodesmidae Cook, 1896

Gasterogramma Jeekel, 1982

Gasterogramma Jeekel, 1982: 10.—Shelley et al., 2000: 102.

Type species. Gasterogramma psi Jeekel, 1982, by original designation.

Included species. G. austrinum sp. nov., *G. imber* sp. nov., *G. extremum* sp. nov., *G. plomleyi* sp. nov., *G. psi* Jeekel, 1982, *G. rusticum* sp. nov., *G. tarkinense* sp. nov. and *G. wynyardense* sp. nov.

Remarks. Jeekel (1982: 10) gave the following diagnosis for somatic features of *Gasterogramma*: "Medium-sized Dalodesmidae with 20 somites and a normal poreformula. Head without particulars; antennae of moderate length, clavate, the 6th antennomere longer than the 5th. Collum without

paranota; the sides almost perpendicular. Somites very weakly constricted, almost cylindrical; the waist broad. Metatergites without sculpture. Paranota weakly developed, ridgelike, only dorsally demarcated by a furrow in which the pores are situated. Sternites much longer than wide, without particular modifications. Legs of moderate length, incrassate in the male and with dense setation of short stiff bristles on ventral side of podomeres 2 to 4 and dense granulation on ventral side of podomeres 5 and 6. Anal somite without particulars." This general description also applies to the seven new species described here but the following generic features should be included: integument well calcified; narrow but clearly distinguishable paranota on second segment, lower on body than the lateral collum margins and the paranotal traces on third segment; gonopod aperture ovoid with long axis transverse, rim not raised in front and variably raised at rear; epiproct blunt, prominent, extending caudad past the anal valves.

Jeekel's diagnosis of the *Gasterogramma* gonopod (1982: 10) is here amended: telopodites elongate, loosely joined medially; solenomerite arising at one-half to two-thirds the length of the telopodite, each solenomerite a small, distally tapering rod twisted in the following sense: a right-handed helix (clockwise turning away from the observer) on the right gonopod, a left-handed helix on the left gonopod.

In an attempt to identify (i.e., homologise) the elements of the *G. psi* gonopod, Jeekel (1982: 11) hypothesised that "the course of the spermal channel [here called "prostatic groove"] is homologous in all polydesmoid millipedes, and that the location of the base of each process in relation to the spermal channel defines its morphological identity." He named the process arising caudad of the prostatic groove the tibiotarsus, and the structure arising cephalad the femoral process. If the distal portion of the *G. psi* gonopod is untwisted, in imagination, then the lateral process with a tip shaped like a bird's head (fig. 6) is identifiable as the femoral process; the anterior, laterally fringed process bearing a rod-like structure is a prolongation of the prefemur; and the rod-like structure is the tibiotarsus. In the notch between the femoral and prefemoral processes arises the solenomerite.

An alternative interpretation is that the distal end of the telopodite is not torted, and that the 'femoral process' is a growth from the caudomedial side of the gonopod which has displaced the prostatic groove laterally. It is important to note that the course of the prostatic groove in *G. psi* is actually two opposed spirals. From the base of the telopodite of the right gonopod, the groove first runs distally in a left-handed spiral to encircle the "femoral process", then in a right-handed spiral upon entering the solenomerite. The cheirality of the spirals on the left gonopod mirrors that on the right. In the three species here assigned to *Gasterogramma* which lack a femoral process (*G. austrinum, G. rusticum* and *G. wynyardense*), the basal spiral is missing but the solenomerite spiral persists.

Jeekel's hypothesis sought to make each gonopod process in polydesmoids a homologue of either the prefemur, femur or tibia+tarsus of the millipede leg, and uses a "fixed" solenomerite as a morphological landmark. If the "no torsion" interpretation of the *Gasterogramma* gonopod is correct, then either the simple notion of homologisation is inadequate, or the solenomerite is not "fixed." Unfortunately, polydesmoid gonopods develop suddenly from unsegmented primordia in the ultimate moult, and there are no visible intermediate stages which would allow us to unambiguously identify individual gonopod processes with prototypical leg segments, in *Gasterogramma* or any other polydesmoid. A correct interpretation of gonopod structure may be possible in future with advances in the developmental genetics of arthropods. For the present, Jeekel's labelling of the gonopod processes in *Gasterogramma* is a useful hypothesis, and is adopted for descriptive purposes in this paper.

Distribution. Western and north-eastern Tasmania (fig. 13); not recorded from King I. or the Furneaux Group in Bass Strait.

Habits. The eight species of *Gasterogramma* are burrowing millipedes typically found in moist, organic-rich soil, in deep moist leaf litter and in and under wet rotting logs. As noted by Jeekel (1982: 9) for *G. psi, Gasterogramma* are "sluggish" and at first sight they resemble "a worm or a dipteran larva rather than a millipede." They are often locally abundant in loose, mixed-age aggregations. All *Gasterogramma* species release a pungent defensive secretion which presumably includes hydrocyanic acid, although this is not the most prominent odour component. The pinkish-purple *Gasterogramma* species have been called "stinky pinkies" by local collectors impressed by the pungency of the secretion. *G. plomley*i has the strongest smell in the genus, and can be detected by treading heavily through its wet forest habitat and sniffing attentively. Unfortunately, no somatic characters have been so far noted which can reliably be used to distinguish the seven western species (i.e., *Gasterogramma* spp. other than *G. plomleyi*), and at many western sites two *Gasterogramma* species are present. I have not, therefore, assigned non-*plomleyi* females and juveniles to species; these individuals are recorded in the separate specimen data table as "*Gasterogramma* sp." Males and females have been found in copula in all months of the year, but mating is most frequent in the austral spring; the only two pairs so far preserved in copula (*G. psi*, QVM 23:8086 and QVM 23:40560) were collected in late November. Females are often found curled around an egg mass; it is unclear whether such females are in the process of constructing an egg chamber (as expected for Polydesmida) or are brooding their eggs.

Relationships. Jeekel (1982: 12) noted that *Gasterogramma* and the Chilean *Semnosoma* Silvestri, 1903 were the only dalodesmid genera in which the prostatic groove had been reported to be helical, and "It seems likely, therefore, that the new genus is closely related to *Semnosoma*. Eventually, the two may form the nucleus of a tribe for which the family-group name Semnosomatidae Brölemann, 1916 is available." The illustrations of *Semnosoma* gonopods in Demange and Silva (1976a, b) show the prostatic groove running first caudally, then laterally, then anteriorly as in *G. psi*. Further, species in the *Semnosoma* group of Chilean dalodesmids (i.e. *Semnosoma, Anaulacodesmus* Attems, 1898, *Chilorus* Chamberlin, 1957

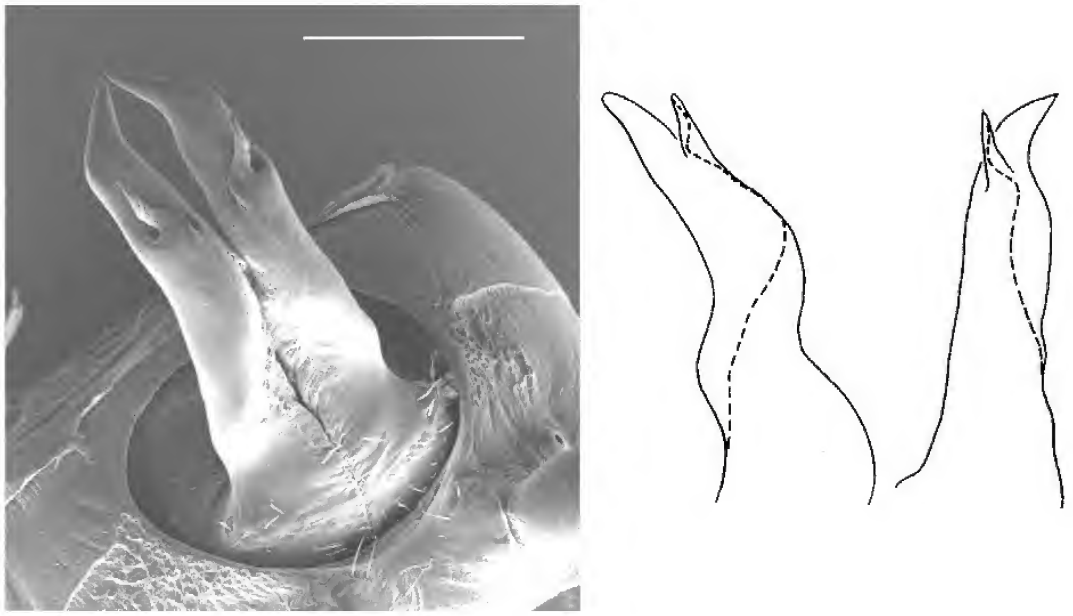

Figure 1. (left) *G. austrinum* sp. nov., Tahune Bridge, southern Tasmania, QVM 23:16195; SEM of gonopods in situ. Scale-bar = 0.5 mm. (right) *G. austrinum* sp. nov., Gold Creek, southern Tasmania, QVM 23:14021; outline sketches of right gonopod showing course of prostatic groove (dashed line): lateral view, left; posterior view, right.

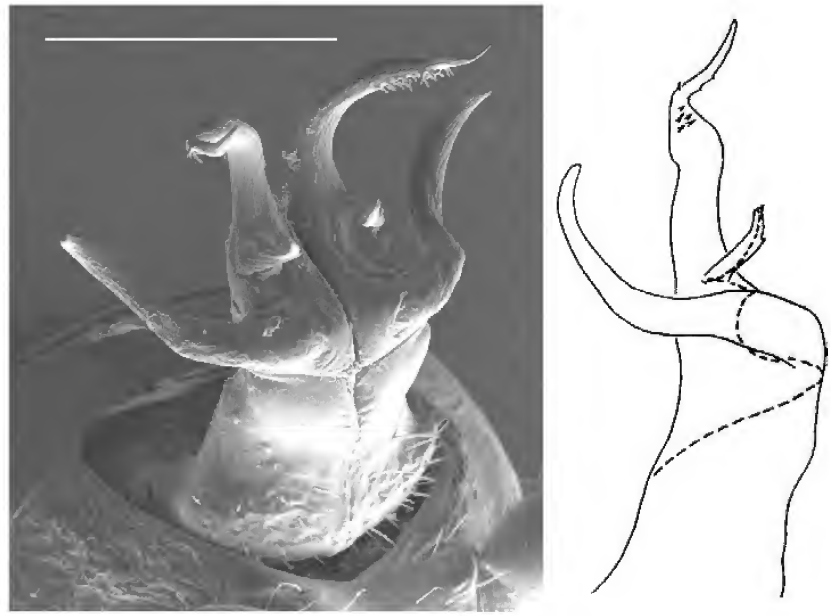

Figure 2. (left) *G. extremum* sp. nov., Lake Sydney, southern Tasmania, QVM 23:14019; SEM of gonopods in situ. Scale-bar = 0.5 mm. (right) *G. extremum* sp. nov., Hastings Caves, southern Tasmania, QVM 23:8059; outline sketch of right gonopod, lateral view, showing course of prostatic groove (dashed line).

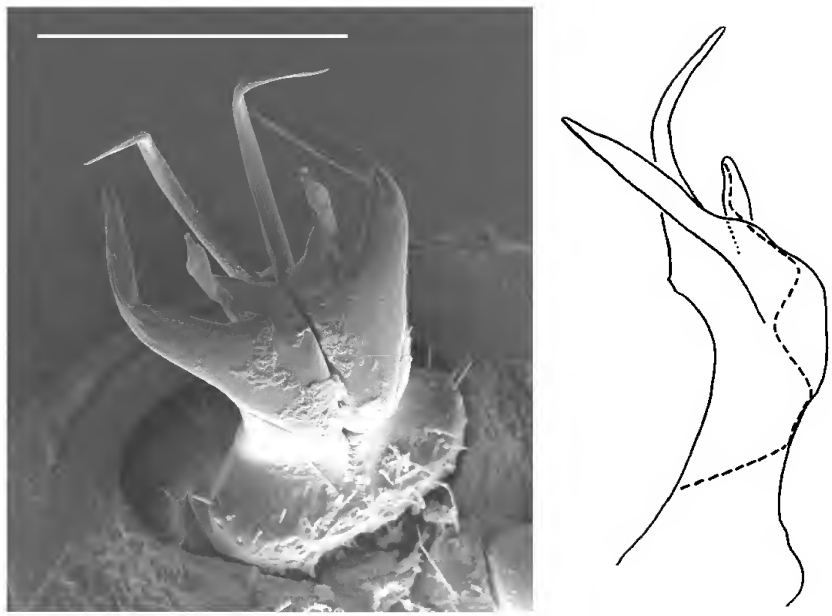

Figure 3. (left) *G. imber* sp. nov., Tarraleah, central Tasmania, QVM 23:8047; SEM of gonopods in situ. Scale-bar = 0.5 mm. Prefemoral processes are parallel in life and in alcohol-preserved material; the divergence seen in this SEM is an artefact of specimen preparation. (right) *G. imber* sp. nov., Argent R., western Tasmania, QVM 23:8051; outline sketch of right gonopod, lateral view, showing course of prostatic groove (dashed line).

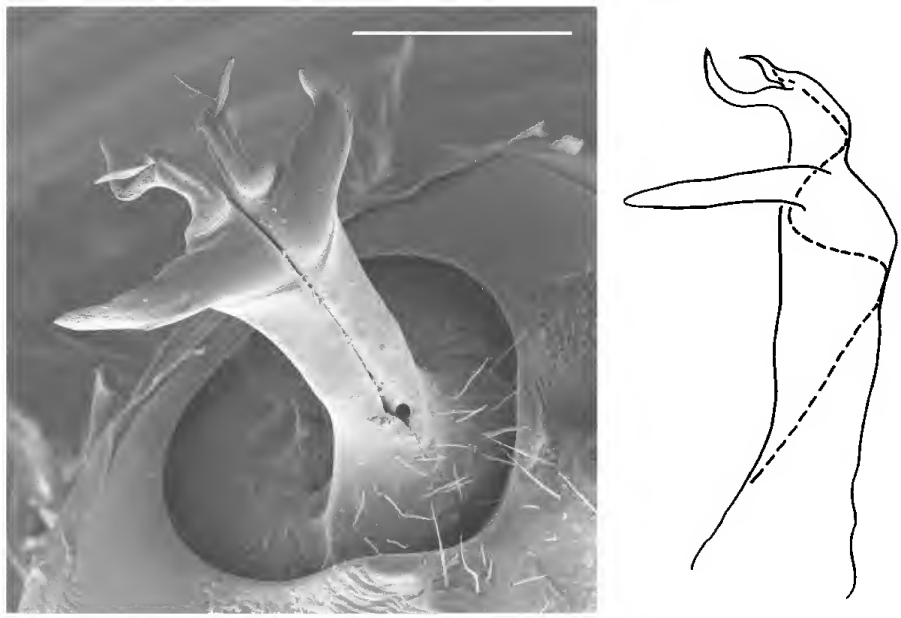

Figure 4. (left) *G. plomleyi* sp. nov., Rattler Hill, north-east Tasmania, QVM 23:8068; SEM of gonopods in situ. Scale-bar = 0.5 mm. (right) *G. plomleyi* sp. nov., Crystal Hill, north-east Tasmania, QVM 23:8069; outline sketch of right gonopod, lateral view, showing course of prostatic groove (dashed line).

and *Tsagonus* Chamberlin, 1957) all have, like *Gasterogramma*, greatly reduced paranota (Chamberlin, 1957: 19). The argument for a Gondwanan dalodesmid lineage including the Chilean and Tasmanian genera thus appears reasonable.

Relationships within *Gasterogramma* are unclear. Grouping phenetically on gonopod form, we might have (*G. extremum* + *G. imber* + *G. plomleyi* + *G. psi* + *G. tarkinense*) with a femoral process and (*G. austrinum* + *G. rusticum* + *G. wynyardense*) without such a process, but relationships within these groups are far from obvious. Both groups are widely dispersed across Tasmania, suggesting that the two might have differentiated independently in the landscape. However (see below) the two groups are not independently distributed: the seven non-*psi* species currently form an allopatric/parapatric mosaic.

Gasterogramma austrinum sp. nov.

Figures 1, 5, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. Huon R. (Arve Rd), DN784273 [43º06´23´´ 146º44´04´´], 120 m, 2 May 1997, R. Mesibov, plot 3M1, oldgrowth wet eucalypt forest with rainforest understorey, QVM 23:40628.

Paratypes. 3 males, Huon R. (Edwards Rd), DN790284 [43º05´48´´ 146º44´31´´], 90 m, 23 May 1997, R. Mesibov, plot 3R6, regrowth wet eucalypt forest following clearfelling and burning, QVM 23:40630; 2 males, Edgar Bay area, DN483404 [42º59´13´´ 146º21´57´´], 350 m, pitfall emptied 16 Nov 2001, D. Driscoll, QVM 23:24802; 4 males, Huon R. (Arve Rd), DN798284 [43º05´48´´ 146º45´06´´], 200 m, 16 May 1997, R. Mesibov, regrowth wet eucalypt forest following clearfelling and burning, AM KS85097 (formerly QVM 23:40629).

Other material. 19 males from 8 unique localities in southern Tasmania, including Gold Creek, Huon R., Kallista Creek, Picton R., Reuben Falls and Tahune Bridge.

Diagnosis. Gonopod with no femoral process or tibiotarsus; telopodite in posterior view ending in broad, mesodistally directed point.

Description. Males c. 17–20 mm long and c. 1.8–2.0 mm wide at midbody. Body in both sexes darkly mottled with pink-purple pigmentation. Gonopod telopodites slender in posterior view, lightly joined for about half their length, a few short, coarse setae at their bases, setate area extending just outside aperture (fig. 1). Aperture more or less ovoid, long axis transverse, posterior margin not noticeably raised. Telopodite with a posteromesal concavity near base, somewhat sinuous in lateral view, curving anteriorly, then distally, then anteriorly and slightly tapering, finally tapering mesally to end in blunt, mesodistally pointed tip. Femoral process and tibiotarsus not evident. Solenomerite short, helical, tapering process arising at about four-fifths length of telopodite on its posterior face. Prostatic groove running distally and posteriorly along mesal side of telopodite, then curving laterally before running straight distally to enter solenomerite on its mesal side.

Distribution. In rainforest and wet eucalypt forest over at least 750 km^2 in southern Tasmania (fig. 12), at altitudes c. 50–600 m.

Etymology. From Latin *austrinus*, southern, adjective. This species is restricted to southern Tasmania.

Gasterogramma extremum sp. nov.

Figures 2, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. Deadmans Bay, DM592802 [43º31´47´´ 146º29´42´´], <40 m, 26 Jan 1994, R. Mesibov, wet eucalypt forest and rainforest, QVM 23:14018.

Paratypes. Male (dissected), near Hastings Caves, approx. DM870960 [43º23´18´´ 146º50´22´´], 5 Dec 1952, V.V. Hickman, QVM 23:8059; male (dissected for SEM), Lake Sydney, DN686070 [43º17´20´´ 146º36´46´´], 690 m, 2 Feb 1994, R, Mesibov, rainforest, QVM 23:14019.

Diagnosis. Gonopod without tibiotarsus; femoral process unbranched; prefemoral process curved laterally, then posteriorly, with short, tooth-like projections near tip; solenomerite arising near base of prefemoral process.

Description. Males c. 15–17 mm long and c. 1.6–1.8 mm wide at midbody. Body in both sexes ivory-coloured with faint pink-purple mottling. Gonopod telopodites massive at base (fig. 2), lightly joined mesally for most of their length, with a few short, coarse basal setae, setate area extending just outside aperture. Aperture more or less ovoid, long axis transverse, posterior margin not noticeably raised. Telopodite axis more or less straight. Telopodite base ending abruptly at about one-half length of telopodite, with a relatively slender, anterioposteriorly flattened prefemoral process arising from anteromesal corner of top of base. Prefemoral process tapering gradually to a fine point, bending first laterally, then posteriorly, and bearing set of 10–20 short, simple or bifid teeth on posterolateral surface just proximal to tip. Tibiotarsus not evident. Femoral process massive, tapering gradually to a fine point, arising from posteromesal corner of top of telopodite base and curving laterally, then anteriorly, then distally and slightly laterally. Solenomerite a short, helical, somewhat flattened process arising at base of prefemoral process on its posterior face. Prostatic groove running first posteriorly and distally across mesal face of telopodite base to its posterior surface, then curving laterally, distally and mesally around base of femoral process, then extending distally to enter solenomerite base on its mesal side.

Distribution. Rainforest and wet eucalypt forest at 3 locations in far southern Tasmania (fig. 12) from near sea level to 690 m, with maximum linear range of c. 30 km. Likely to be more widespread in this little-sampled part of Tasmania.

Etymology. From Latin *extremus*, farthest, adjective. This species extends to the southern-most part of mainland Tasmania.

Gasterogramma imber sp. nov.

Figure 3, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. Little Florentine R., DN525683 [42º44´10´´ 146º25´10´´], 440 m, pitfall emptied 10 Apr 1986, R. Bashford, QVM 23:24958.

Paratypes. Male, details as for holotype, QVM 23:40586; male, Tarraleah, DP473196 [42º16´25´´ 146º21´39´´], 750 m, 4 May 1992, R. Mesibov, oldgrowth wet eucalypt forest with rainforest understorey, QVM 23:8048; male, Needles Picnic Ground, DN512656 [42º45´37´´ 146º24´12´´], 470 m, 23 Feb 1994, R. Mesibov, oldgrowth wet eucalypt forest with rainforest understorey, QVM 23:13840; 5 males,

Tarraleah, DP473197 [42°16′22″ 146°21′39″], 780 m, 5 May 1992, R. Mesibov, oldgrowth wet eucalypt forest with rainforest understorey, AM KS85098 (formerly QVM 23:8045).

Other material. 49 males from 26 unique localities in central, south-western and western Tasmania, including Argent R., Boyd R., Denison R., Franklin R., Frenchmans Cap, Gordon R., Humboldt Divide, Huon R., Kallista Creek, Little Florentine R., Mossy Marsh Creek, Queenstown, Scotts Peak Dam, Taffys Creek, Tarraleah, Trappes Inlet, Wedge Inlet and Wedge R..

Diagnosis. Gonopod without tibiotarus; femoral process unbranched; prefemoral process slender, straight, without tooth-like projections, flexed sharply at tip; solenomerite rising near base of prefemoral process.

Description. Males c. 17–20 mm long and c. 1.8–2.0 mm wide at midbody. Body in both sexes darkly mottled with pink-purple pigmentation. Gonopod telopodites massive at base (fig. 3), lightly joined mesally for about half their length, a few short, coarse basal setae, setate area extending just outside aperture. Aperture more or less ovoid, long axis transverse, posterior margin not noticeably raised. Telopodite narrowing near its base, bending slightly in anterior direction at about half telopodite length, narrowing greatly and abruptly at bend and extending from anteromesal corner of top of base as a spear-like, sharply pointed prefemoral process flexed sharply posteriolaterally at about three-quarters of its length. (In life and in alcohol preservative, axis of prefemoral process parallels that of telopodite; prefemoral processes in SEM image in fig. 3 bend laterally at their bases as a result of drying-out during specimen preservation) Tibiotarsus not evident. Femoral process massive, arising from posterior face of telopodite base and directed laterally and distally, bending sharply anteriorly and distally at about two-thirds its length and tapering to a blunt point. Solenomerite a short, helical, tapering, somewhat flattened process arising between bases of femoral and prefemoral processes. Prostatic groove running first posteriorly and distally across mesal face of telopodite base to its posterior surface, then curving laterally, distally and mesally around base of femoral process, then extending distally to enter solenomerite base on its mesal side.

Distribution. In rainforest and wet eucalypt forest over at least 6000 km^2 in western Tasmania (fig. 12), at altitudes c. 50–800 m. Syntopic with *G. psi* at various locations through its range.

Etymology. Latin *imber*, shower, noun in apposition. This species occurs in the highest rainfall zone in Tasmania.

Gasterogramma plomleyi sp. nov.

Figures 4, 5, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. Rattler Hill, EQ744353 [41°13′48″ 147°53′15″], 650 m, 29 Aug 1990, R. Mesibov, oldgrowth rainforest, QVM 23:24960.

Paratypes. 2 males (1 dissected for SEM), details as for holotype, QVM 23:8068; 2 females, details as for holotype, QVM 23:8307; 3 males, Forest Lodge, EQ786296 [41°16′51″ 147°56′18″], 410 m, 13 Jan 1993, R. Mesibov, wet eucalypt forest, QVM 23:8066; 1 male, Pecks Hill, EQ282251 [41°19′29″ 147°20′13″], 450 m, 14 Jan 1993, R. Mesibov, wet eucalypt forest, QVM 23:8061; 3 males, Williams Hill, EQ558548 [41°03′21″ 147°39′50″], 300 m, 10 Mar 1993, R. Mesibov, wet eucalypt forest, QVM 23:16477; 3 males, Mathinna Plains, EQ616221 [41°21′00″ 147°44′10″], 800 m, 12 Jan 1993, R. Mesibov, AM KS85099 (formerly QVM 23:8063).

Other material. 26 males, 40 females and 52 juveniles from 33 unique localities in north-east Tasmania, including Carters Creek, Chinaman Corner, Crystal Hill, Cuckoo, Forest Lodge, Golconda, Hogarth Rivulet, Joseph Creek, Lisle, Mathinna Plains, Milly Brook, Mt Arthur, Mt Michael, Mt Victoria, Northallerton Valley, Patersonia Rivulet, Pecks Hill, Peddles Hill, Rattler Hill, Rayners Hill, Sideling Range, South Springfield, Tombstone Creek, Weldborough and Williams Hill.

Diagnosis. Epiproct unusually broad, with bumpy appearance (fig. 5B). Gonopod without tibiotarsus; femoral process unbranched; prefemoral process short, without tooth-like projections, bent anteriorly, then distally and mesally; solenomerite seemingly fused with prefemoral process for half length of latter.

Description. Males c. 20–23 mm long and c. 2.0–2.4 mm wide at midbody, females somewhat larger. Body in both sexes fairly uniformly ivory-coloured. Epiproct (fig. 5B) enlarged relative to other *Gasterogramma* (fig. 5A), lateral and terminal setae on prominent bumps (fig. 5C). Gonopod telopodites (fig. 4) fairly straight and slender, lightly joined mesally for most of their length, a few long setae at their bases just inside aperture. Aperture more or less ovoid, long axis transverse, posterior margin very slightly raised and broadly, medially notched. Femoral process massive, arising on posteromesal face of telopodite at about two-thirds its length, directed laterally and slightly distally before turning abruptly anteriorly at about half length of process and tapering to a blunt point. Telopodite extending from femoral process base as a short, slender prefemoral process which bends anteriorly, then curves distally and mesally to terminate in a fine point. Tibiotarsus not evident. Solenomerite about as long as prefemoral process, arising near base of prefemoral process on its posterior face and apparently fused with it to point where prefemoral process bends anteriorly, from this point helical and slightly flattened. Prostatic groove running distally and posteriorly across mesal surface of telopodite, then curving laterally, distally and mesodistally around femoral process before entering solenomerite on its mesal side. Cyphopods not examined.

Distribution. In rainforest and wet eucalypt forest over c. 1700 km^2 in high-rainfall parts of north-east Tasmania (fig. 12), at altitudes 150–850 m.

Etymology. In honour of Brian Plomley (1912–1994), Tasmanian scientist and scholar who encouraged biological research in north-east Tasmania.

Gasterogramma psi Jeekel, 1982

Figures 6, 7, 11 (map)

Gasterogramma psi Jeekel, 1982: 12.—Shelley et al., 2000: 102.

Holotype. Male. Australia, Tasmania. "Sta. 100, Hellyer Gorge, 32 km SSW Somerset, 25.XI.1980 (temperate rain-forest (*Nothofagus, Eucalyptus, Dicksonia*) along the Hellyer R., under logs)" (Jeekel, 1982: 12). Holotype probably in Zoological Museum, Amsterdam; not examined.

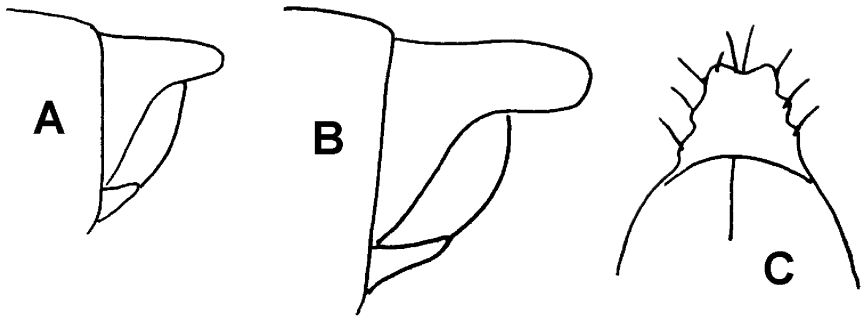

Figure 5. Sketches of epiproct form. A, Typical form in *Gasterogramma; G. austrinum* paratype, QVM 23:40629; lateral view. B, *G. plomleyi*, male paratype, QVM 23:8068, lateral view. C, same specimen as B, ventral view.

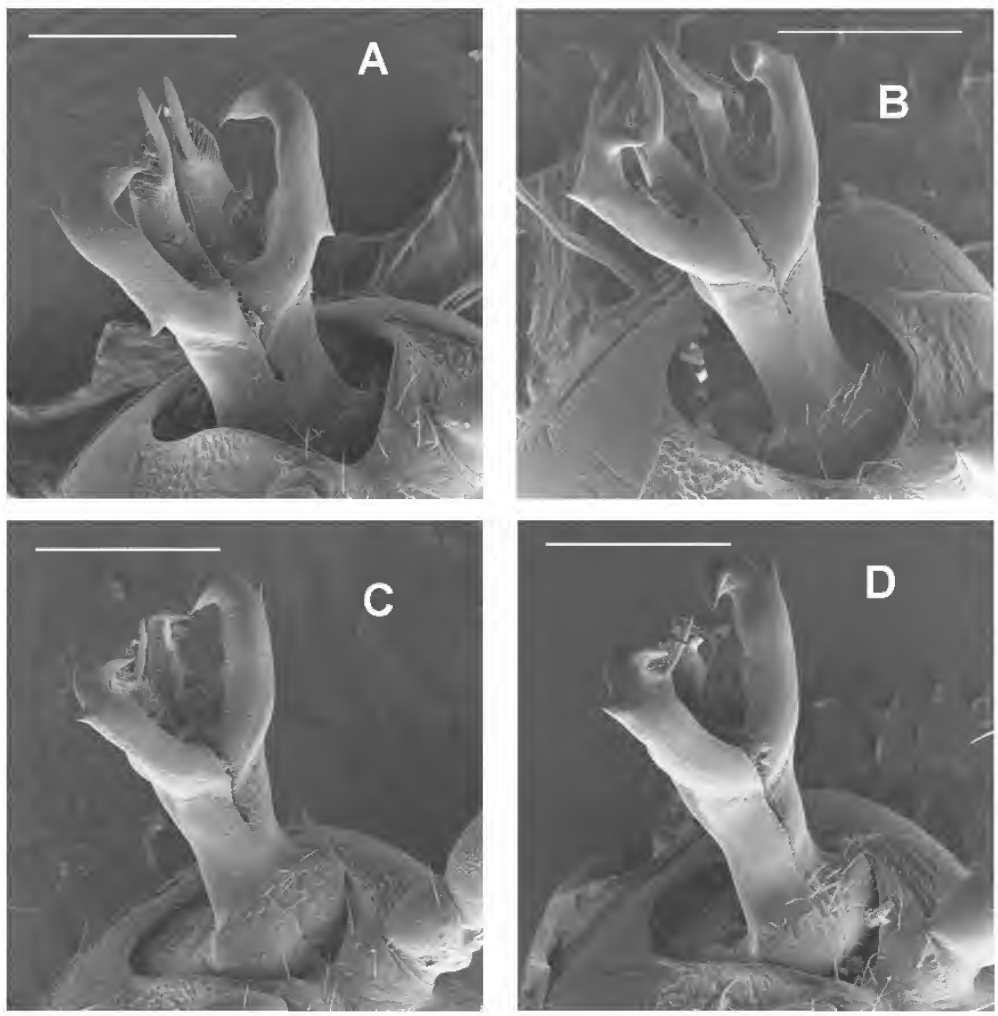

Figure 6. A–D, *G. psi* gonopod variations, seen in situ; see fig. 11 for locations. A, Washpond Forest, north-west Tasmania, QVM 23:8085. B, Notley Gorge, north-central Tasmania, QVM 23:8139. C, Coles Creek, central Tasmania, QVM 23:24797. D, Henty R., western Tasmania, QVM 23:8143. Scale-bar in all cases = 0.5 mm.

Figure 7. A–C, body pattern variations in *G. psi*. A, almost uniformly pale; Cam R., north-west Tasmania. B, dark-spotted; Dial Range, north-west Tasmania. C, dark with faint mottling; Florentine R., south-west Tasmania.

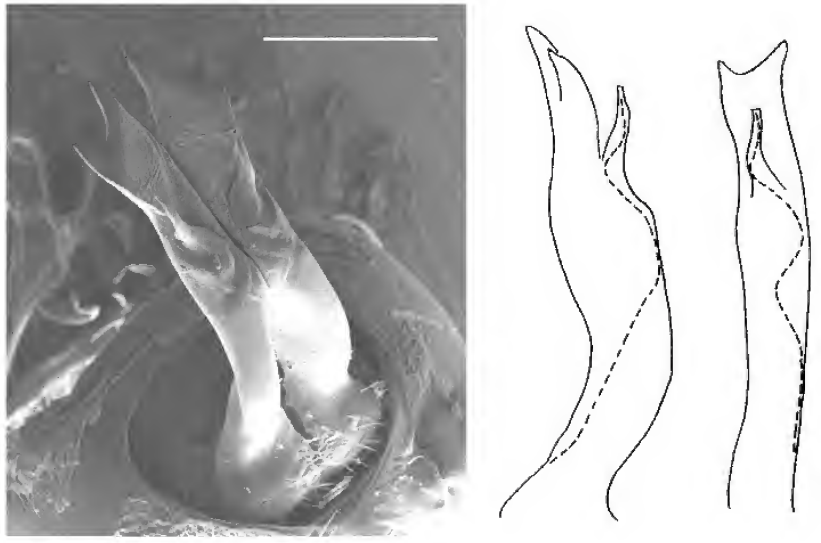

Figure 8. (left) *G. rusticum* sp. nov., Don Reserve, north-central Tasmania, QVM 23:16199; SEM of gonopods in situ. Scale-bar = 0.5 mm. (right) *G. rusticum* sp. nov., Gog Range, north-central Tasmania, QVM 23:8053; outline sketches of right gonopod showing course of prostatic groove (dashed line): lateral view, left; posterior view, right.

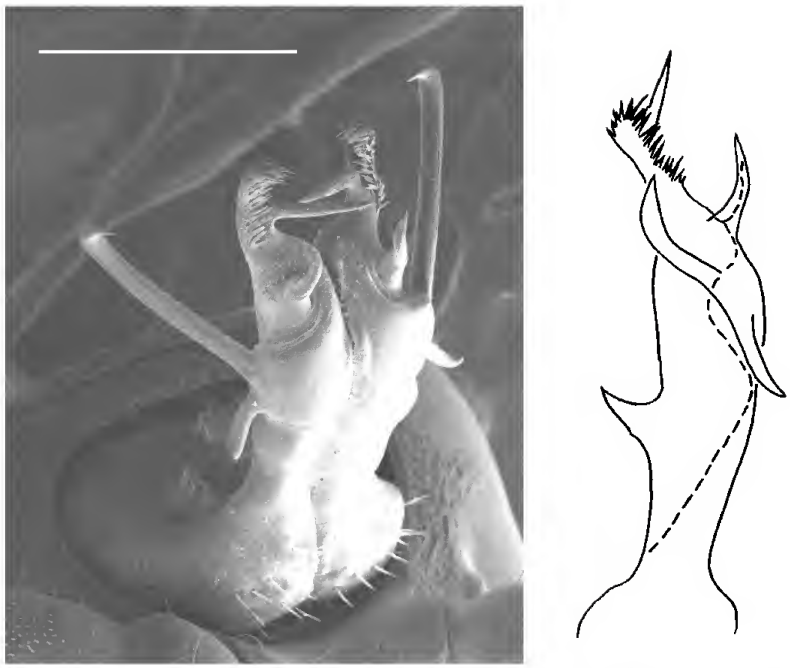

Figure 9. (left) *G. tarkinense* sp. nov., The Clump, north-west Tasmania, QVM 23:8056; SEM of gonopods in situ. Scale-bar = 0.5 mm. (right) *G. tarkinense* sp. nov., Wombat Hill, north-west Tasmania, QVM 23:8057; outline sketch of right gonopod showing course of prostatic groove (dashed line).

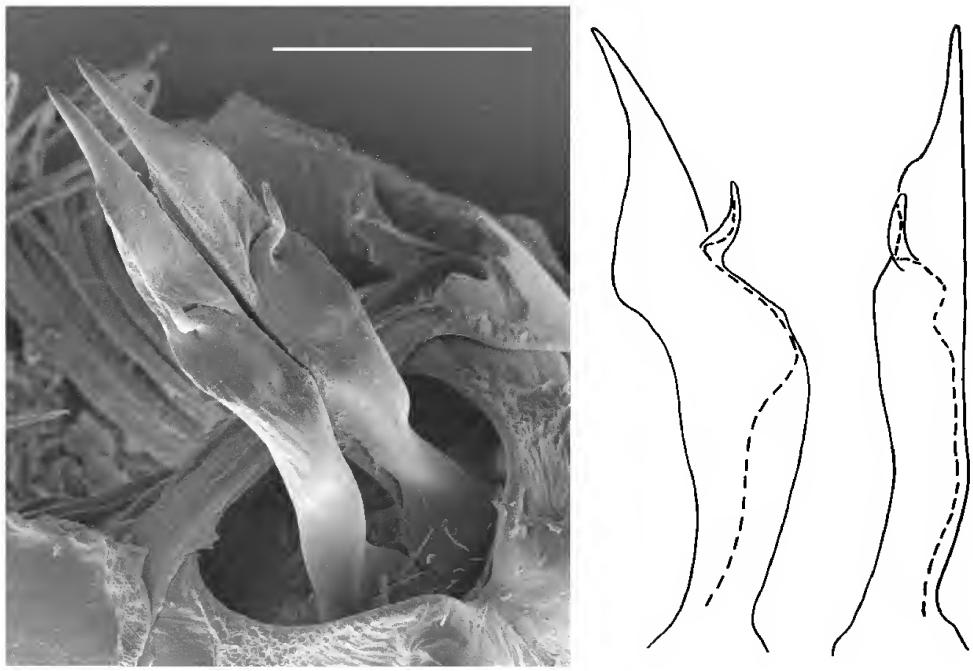

Figure 10. (left) *G. wynyardense* sp. nov., Inglis R., north-west Tasmania, QVM 23:41909; SEM of gonopods in situ. Scale-bar = 0.5 mm. (right) *G. wynyardense* sp. nov., Seabrook Creek, north-west Tasmania, QVM 23:40632; outline sketches of right gonopod showing course of prostatic groove (dashed line): lateral view, left; posterior view, right.

Material examined. Paratypes. 10 males, 12 females, 3 stadium VII males, 3 stadium VI males, collection details as for holotype; locations unknown.

Other material. 393 males from 190 unique localities in northern and western Tasmania, including Allen Creek, Animal Creek, Arthur R., Balfour, Bellana Creek, Big Creek, Black Bog Creek, Black R., Blackfish Creek, Bond Tier, Bonneys Tier, Borradale Creek, Branchs Creek, Broadsword cave (Gunns Plains), Brooks Creek, Bubs Hill, Burnie Park, Burning Down the House cave (Junee–Florentine), Cam R., Cann Creek, Central Castra, Chester Creek, Christmas Hill, Christmas Hills, Coles Creek, Companion Hill, Companion Rd, Crayfish Creek, Dalgarth Forest Reserve, Dark Creek, Dawson R., Dead End Den cave (Mt Cripps), Dee Lagoon, Deep Creek Bay, Denison R., Dip R., Don R., Duck Creek, Dundas R., East Ridgley, Emu R., Fisher R., Florentine R., Flowerdale, Gawler R., Gibson Creek, Goderich Rd, Gordon R., Guildford Rd, Hardwood R., Heemskirk Rd, Henty R., Hermit Hill, Holwell Gorge, Inglis R., Interview R., Jessie Rd, Jones Creek, Julius R., Kelcey Tier, Kenzies Hill, Lake Chisholm, Lake Lea, Lake Mackenzie, Laughing Jack Lagoon, Lawson Plains, Library Creek, Little Claytons Rivulet, Loongana cave L9, Maggs Mountain, Mahoneys Creek, Marine Creek, Maxwell R., Mersey R., Meunna, Meunna Hills, Milkshakes, Montagu Swamp, Mossy Marsh Creek, Mostyn Hardy cave (Loongana), Mt Oakleigh, Mt Sprent, Newall Creek, Nietta Creek, No Mans Creek, Nook, Notley Gorge, Olga R., Orange R., Ordnance Point, Parrawe Creek, Pelion Valley, Pencil Pine Creek, Philrod cave (Mt Cripps), Poppys Lagoon, Punchs Terror, Richardsons Flats, Roger R., Roger R. West, Rosebery, Salmon R., Sassafras Creek, Savage R., Saxons Creek, Scopus, Seabrook Creek, Serpentine Dam, Shadow Lake, Sisters Creek, Smithton, Somerset, Sterling R., Stony Rises, Sundown Point, Table Cape, Tarraleah, Three Hummock I., Trowutta Caves, Tunnel, Upper Natone, Wakefield Creek, Wandle R., Washpond Forest, Weaning Paddock Creek, Welcome Heath, West Montagu, Whisky Creek, Wild Wave R., Williamsford, Wilsons Creek and Wombat Hill.

Diagnosis. Gonopod with femoral process terminating in a mesally directed tip with shape of bird's head; prefemoral process fringed with tooth-like projections; tibiotarsus prominent, distally or distally and mesally directed; solenomerite arising near base of prefemoral process.

Descriptive notes. For a very detailed description of this species, see Jeekel (1982: 12–14). Variations in gonopod structure and body colour pattern (see below) occur across the range of *G. psi*, but I am reluctant to divide *G. psi* into subspecies.

Gonopod: The form described by Jeekel (1982) from north-west Tasmania (site "TL" in fig. 11) extends with little variation to central Tasmania. In the latter area ("C" in fig. 11), the tip of the prefemoral process is shortened and bent slightly posteriorly (fig. 6C). In the central west ("D" in fig. 11), the tip of the prefemoral process is further flexed and lies lateral to the tibiotarsus, which is directed posteriomesally (fig. 6D) rather than standing more or less "upright" as in north-west forms. In the far north-west ("A" in fig. 11), the tibiotarsus extends well distal of the prefemoral process, and a second small, lateral tooth is present towards the base of the femoral process (fig. 6A). In the north-east of the *G. psi* range ("B" in fig. 11), the tibiotarsus is enlarged and directed slightly mesally, and the tips of the femoral process turn slightly posteriorly (fig. 6B).

Colour: Over much of the western and north-western portion of its range, *G. psi* is pale with very faint, brownish gray markings (fig. 7A). In the north of the range almost all specimens have a striking pattern of dark lateral spots on the segments with ozopores (5, 7, 9, 10, 12, 13, 15–18; fig. 7B), while specimens from the south and central portions of the *G. psi* range are dark with faint mottling (fig. 7C).

Distribution. From sea level to c. 1250 m over c. 25 000 km^2 in northern and western Tasmania, including Three Hummock Island in Bass Strait (fig. 11). In coastal, subalpine and riparian scrubs; in swamp forest, wet eucalypt forest and rainforest; in exotic tree plantations; and occasionally in caves. Syntopic with *G. imber, G. rusticum, G. tarkinense*, and *G. wynyardense* over parts of its range.

Remarks. Gasterogramma psi is the most ecologically tolerant species of the genus in north-west Tasmania, and is generally more abundant than co-occurring *G. rusticum, G. tarkinense* or *G. wynyardense*.

Gasterogramma rusticum sp. nov.

Figures 8, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. Christmas Hill, DQ697095, 340 m, 10 Nov 1993, R. Mesibov, wet eucalypt forest, QVM 23:16476.

Paratypes. 2 males, Little Claytons Rivulet, DQ321385 [41°12′06″ 146°11′24″], 80 m, 31 Oct 1996, R. Mesibov, wet eucalypt forest, QVM 23:40594; 2 males, Elizabeth Town, DQ633091 [41°28′07″ 146°33′37″], 210 m, 17 Sep 1997, R. Mesibov, wet eucalypt forest, QVM 23:40600; 5 males, Gawler R., DQ277347 [41°14′08″ 146°08′14″], 150 m, 29 Apr 1999, K. Bonham, site 6b, blackwood forest, AM KS 85100 (formerly QVM 23:41901).

Other material. 31 males from 21 unique localities in northern Tasmania, including Caroline Creek, Christmas Hill, Dalgarth Forest Reserve, Dasher R., Don Reserve, Dulverton, Dysodile Hills, East Gawler R., Gog Range, Kelcey Tier, Latrobe, Lobster Rivulet, Long Hill, Marine Creek, Mersey R., Nook, Staggs Hill, Stella Glen, Warners Sugarloaf and Winter Brook.

Diagnosis. Gonopod with no femoral process or tibiotarsus; telopodite in posterior view with broadly notched tip, i.e. with 2 well-separated terminal teeth.

Description. Males c. 17–20 mm long and c. 1.8–2.0 mm wide at midbody. Body in both sexes lightly mottled with brownish-pink pigmentation. Gonopod telopodites slender, more or less straight, lightly joined for about middle third of their length, a few short, coarse setae near bases just inside aperture (fig. 8). Aperture more or less ovoid, long axis transverse, posterior margin not noticeably raised. Telopodite slightly sinuous in lateral view, curving first anteriorly, then distally, then anteriorly, anterioposteriorly flattened towards its end and bending slightly laterally, broadly notched at its terminus to form two subequal teeth. No evidence of femoral process or tibiotarsus. Solenomerite short, helical, tapering process arising at about three-quarters of length of telopodite on its posterior face. Prostatic groove running distally and posteriorly on mesal side of telopodite, then bending first laterally, then mesally on posterior telopodite surface before running distally to enter solenomerite on its mesal side.

Distribution. In rainforest and wet eucalypt forest over c. 2300 km^2 in north-central Tasmania (fig. 12), from sea level to

c. 700 m. Syntopic with *G. psi* at various locations through its range.

Etymology. From Latin *rusticus*, rural, adjective. Much of the range of this species is now an intensively farmed landscape.

Gasterogramma tarkinense sp. nov.

Figures 9, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. The Clump, CQ213361 [41°12′23″ 144°52′06″], 190 m, 6 Feb 1992, R. Mesibov, wet eucalypt forest, QVM 23:8058.

Paratypes. 3 males (1 dissected for SEM), details as for holotype but 17 Sep 1989, QVM 23:8056; 1 male, Little Donaldson R. area, CQ552256 [41°18′28″ 145°16′12″], 500 m, 7 Jan 1997, ANZSES personnel, rainforest, AM KS85101 (formerly QVM 23:40584).

Other material. One male each from Newdegate Creek and Waratah in north-west Tasmania.

Diagnosis. Gonopod with branched femoral process; tibiotarsus prominent, directed mesally and posteriorly from prefemoral process fringed with tooth-like projections; solenomerite arising near base of prefemoral process.

Description. Males c. 17–20 mm long and c. 1.8–2.0 mm wide at midbody. Body in both sexes ivory-coloured with traces of pink-purple pigmentation middorsally and anteriorly on each segment. Gonopod telopodites slender, narrowing somewhat near base, lightly joined mesally for about two-thirds their length, at which point they bend slightly anteriorly (fig. 9). A projection like a shark's dorsal fin, pointed distally, on anterior surface of telopodite at about one-third its length. A few short, coarse setae at telopodite bases, setate area extending just outside aperture. Aperture more or less ovoid, long axis transverse, posterior margin not noticeably raised. Telopodite flattened anterioposteriorly past bend and tapering laterally, with a lateral and terminal fringe of c. 20 short teeth, simple and bifid, directed posteriorly on tapered portion. Tibiotarsus about as long as tapered portion of prefemoral process, a straight, pointed rod arising on mesal side of prefemoral process at about halfway along tapered portion and directed mesally and posteriorly. Femoral process beginning as a bulge on posterior surface of telopodite just proximal to bend, extending laterally in two diverging, rod-like branches. Distal branch straight, directed distally and laterally and terminating abruptly in a finely pointed, posteriorly directed hook. Proximal branch about one-third length of distal branch, directed proximally and laterally and curving posteriorly at its blunt tip. Solenomerite a short, helical, tapering process arising near base of prefemoral process on its posterior face. Prostatic groove running distally and posteriorly on mesal side of telopodite, then curving laterally, then distally, then mesally around femoral process before running distally to enter solenomerite on its mesal side.

Distribution. Rainforest and wet eucalypt forest at four sites in north-west Tasmania (fig. 12), at altitudes c. 200–900 m, with an estimated minimum range of c. 2300 km^2. Syntopic with *G. psi* on Wombat Hill, near Waratah.

Etymology. Adjectival form of Tarkine, a popular name for the area between the Arthur and Pieman Rivers where the range of this species is centred.

Gasterogramma wynyardense sp. nov.

Figures 10, 12 (map)

Material examined. Holotype. Male. Australia, Tasmania. Inglis R., CQ850382 [41°11′57″ 145°37′42″], 390 m, 27 May 1999, K. Bonham, site 35b, wet eucalypt forest, QVM 23:41910.

Paratypes. 2 males, details as for holotype, QVM 23:41910; 1 male, Meryanna, CQ388491 [41°05′35″ 145°04′50″], 190 m, 10 Apr 1999, R. Mesibov, rainforest, QVM 23:41044

Other material. 9 males from 8 unique localities in north-west Tasmania: Arthur R., Blackfish Creek, Cam R., Inglis R., Julius R., Oonah, Seabrook Creek and Sumac Rivulet.

Diagnosis. Gonopod with no femoral process or tibiotarsus; telopodite in posterior view ending in a narrow, distally directed point

Description. Males c. 15–17 mm long and c. 1.6–1.8 mm wide at midbody. Body in both sexes lightly mottled with brownish-pink pigmentation. Gonopod telopodites slender (fig. 10), arising from syncoxite well-separated, but lightly joined from about one-third their length, a few short, coarse setae at telopodite bases within aperture. Aperture more or less ovoid, long axis transverse, posterior margin slightly raised and narrowly, medially notched. Each telopodite bends anteriorly at about half its length, bears a narrow, smoothly curved ridge on its anterior surface at about three-quarters of its length, and tapers mesally to blunt point. Solenomerite short, helical process arising from flattened area on posterior side of telopodite just distal to its bend, solenomerite cradled at its base in a shallow depression in telopodite. Prostatic groove running distally on mesal side of telopodite to vicinity of bend, then curving to posterior side of telopodite, entering base of solenomerite on a slightly sinuous, distal course. No indication of a femoral process or a tibiotarsus.

Distribution. Rainforest and closed wet eucalypt forest (and exotic tree plantations) over at least 900 km^2 in north-west Tasmania (fig. 12), from near sea level to c. 500 m. Syntopic with *G. psi* at various locations through its range.

Etymology. Adjectival form of Wynyard, a Tasmanian town close to which this species is abundant.

Gasterogramma sp.

Material. 2 males. Australia, Tasmania. Cam R. area, DQ019512 [41°05′03″ 145°49′55″], 140 m, 30 Jul 1997, R. Mesibov and R. van Riet, QVM 23:40634.

Remarks. These specimens were found at the extreme eastern end of the *G. wynyardense* range, close to a locality for that species. However, they seem closest to *G. rusticum*: the prefemoral prolongation has a wide terminal notch, the prostatic groove has an "S-bend" as it crosses the posterior face of the telopodite, and the body is larger and more deeply pigmented than it is in *G. wynyardens*e. They differ from *G. rusticum* in having a mesodistally directed, spike-like process arising on the mesoposterior face of the telopodite at about the level of the solenomerite. One interpretation is that the specimens represent a disjunct *G. rusticum* population (the nearest known *G. rusticum* locality is 30 km to the east) which

has long been separated from the main population and is somewhat differentiated. It is curious that the specimens were collected at the edge of the *wynyardense/rusticum* distribution gap, in which only *G. psi* has so far been found. Genetic studies of *Gasterogramma* populations in the area may help to clarify the taxonomic situation.

Biogeography and conservation

Gasterogramma is largely restricted to areas with an annual rainfall greater than 1000 mm (fig. 13), i.e. to areas which at least potentially carry wet forest habitat. The distributions of individual species, however, are not as simply explained. *Gasterogramma psi* occupies the north-western third of Tasmania (fig. 11) from sea level to nearly 1300 m, and is sympatric with *G. imber, G. rusticum, G. tarkinense* and *G. wynyardense*. There is no obvious ecological reason why *G. psi* could not extend into the ranges of *G. austrinum* and *G. extremum* in the south, or into the *G. plomleyi* range in the north-east (the closest known approach to the latter is only 12 km through formerly forested country).

The seven newly described species in the genus form an allopatric/parapatric spatial mosaic (fig. 12). In north-east Tasmania, the *G. plomleyi* range is closely congruent with that of the land snail *Anoglypta launcestonensis* (Reeve, 1853). These two distributions partly define the area of endemism known as Plomleys Island (Mesibov, 1994), which is also characterised by the presence of a number of other narrow-range endemic invertebrates and by the absence of some wide-ranging species. On the north coast, the 30-km-wide gap between the ranges of *G. wynyardense* and *G. rusticum* is now largely farmland. A search of forest remnants in the gap has so far yielded only *G. psi*, so it is not known whether *G. wynyardense* met *G. rusticum* in parapatry before forests in the gap were cleared for agriculture. Parapatric boundaries may yet be found between *G. wynyardense* and *G. tarkinense* and between *G. tarkinense* and *G. imber* in the relatively inaccessible forests of the Arthur-Pieman area in north-west Tasmania, and between *G. austrinum* and *G. extremum* in the wilderness forests of the upper Picton R. catchment. The Gordon River Rd in south-west Tasmania crosses the *G. imber/G. austrinum* parapatric zone and the easy access afforded by this road has facilitated preliminary fine-scale mapping of the two species. As with parapatric millipedes in north-east Tasmania (Mesibov, 1997), the two ranges overlap in a zone less than 1 km wide, and a site has been found along the road where *G. austrinum* and *G. imber* co-occur in litter at the base of a single large tree (see separate specimen table). Possible historical explanations for the mosaic distribution pattern seen in *Gasterogramma* will be discussed elsewhere.

Where rotting logs and deep, well-drained forest soils are available as refuges, the four northern *Gasterogramma* species (*G. plomleyi, G. psi, G. rusticum* and *G. wynyardense*) and the southern *G. austrinum* appear to tolerate burning, logging and partial clearing of their wet forest habitat. *G. psi* and *G. wynyardense* are also known to tolerate replacement of native forest by exotic tree plantation. A survey of litter invertebrates in north-west Tasmania (Bonham et al., 2002) found these two species to be equally abundant in forest plantations (mainly *Pinus radiata*) and nearby native forest. Remarkably, *G. psi* has been collected in tiny (<0.25 ha) degraded remnants of riparian eucalypt forest on farms, having evidently persisted in the litter under a few surviving eucalypt trees for many years.

Although *G. rusticum* and *G. wynyardense* have lost substantial portions of their ranges to agriculture on the more fertile soils of northern Tasmania, all eight *Gasterogramma* species can be regarded as well conserved. All are known to occur (or are likely to occur) in formal, forested reserves within their respective ranges, and all seem likely to persist indefinitely outside reserves under land management regimes which perpetuate closed forest cover, i.e. logging and regeneration of native forest, and plantation forestry.

Acknowledgments

I am grateful to the Plomley Foundation for financial assistance, to David Steele (University of Tasmania) for acquiring the SEM images.

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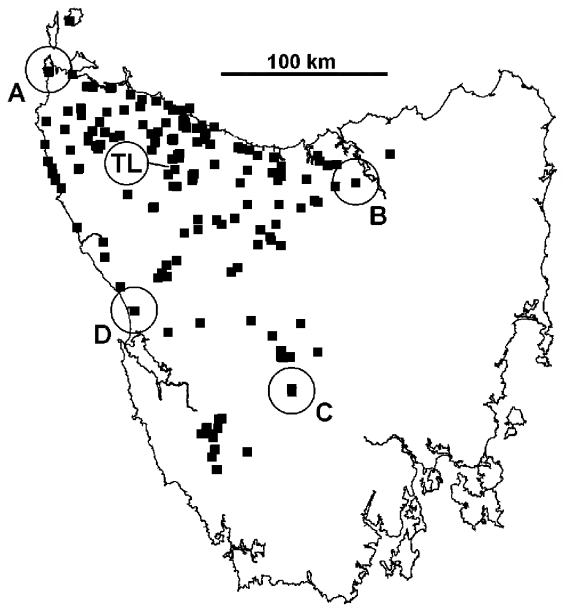

Figure 11. Localities (squares) for *G. psi* males. Circled and labelled localities correspond to the four sites noted in fig. 6: A, Washpond Forest, B, Notley Gorge, C, Coles Creek, D, Henty R. "TL" points to the type locality, Hellyer Gorge.

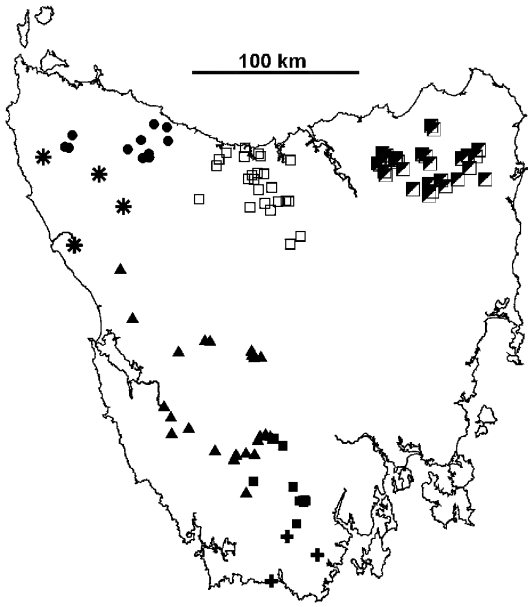

Figure 12. Localities for males of *G. austrinum* sp. nov. (■ south), *G. extremum* sp. nov. (+, far south), *G. imber* sp. nov. (▲, west and south-west), *G. rusticum* sp. nov. (□, north-central), *G. tarkinense* sp. nov. (*, north-west) and *G. wynyardense* sp. nov. (•, north-west), and for all specimens of *G. plomleyi* sp. nov. (half-filled squares, north-east).

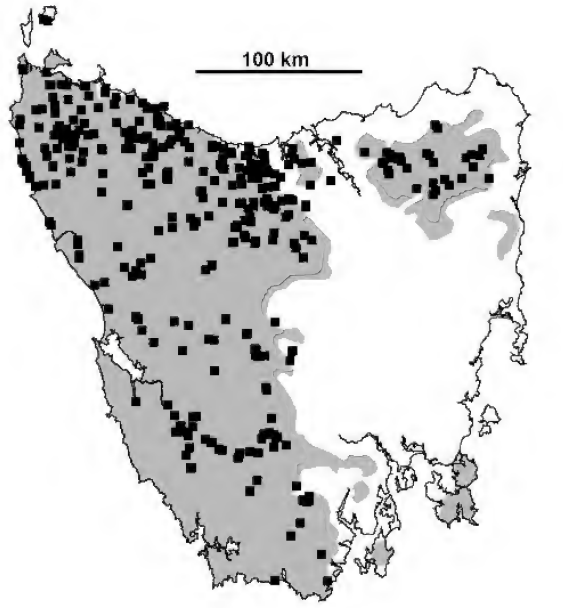

Figure 13. All known localities for *Gasterogramma* spp. (■). Shaded areas have annual rainfall of at least 1000 mm.

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New species of *Goreopagurus* (Decapoda: Anomura: Paguridae) from Tasmania and reevaluation of sexual tubes in hermit crab systematics

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Abstract Lemaitre, R. and McLaughlin, P.A. 2003. New species of *Goreopagurus* (Decapoda: Anomura: Paguridae) from Tasmania and reevaluation of sexual tubes in hermit crab systematics. *Memoirs of Museum Victoria* 60(2): 221–227.

A new, deep-water species is assigned to the hermit crab genus *Goreopagurus* McLaughlin, 1988, previously known only from western Atlantic and eastern Pacific waters. The assignment is made because of the unusual and sexually dimorphic expansion of the right cheliped characteristic of species of this genus. However, in contrast to its congeners, *Goreopagurus poorei* sp. nov. has distally quadriserial gills and exhibits no male sexual tube development. The latter condition has made it necessary to reevaluate the emphasis placed on sexual tubes in paguroid systematics. *Goreopagurus* has been emended to accommodate this species.

Keywords Crustacea, Anomura, Paguroidea, Paguridae, *Goreopagurus*, taxonomy

Introduction

McLaughlin (1988) proposed the genus *Goreopagurus* for a small hermit crab, *Pagurus piercei* Wass, 1963. Wass' (1963) original description of *P. piercei* was based on a single male from off Port Aransas, Texas, USA., and while the species was found in substantial numbers in the Middle Atlantic Bight (Wenner and Boesch, 1979), it was not until it was collected off the east Florida continental shelf that a critical morphological examination was conducted. McLaughlin (1988) found that adult females of *P. piercei* were provided with paired and modified first pleopods; mature males were found to have a short sexual tube produced from the gonopore on the right fifth coxa, and frequently a very short tube or papilla was produced from the left gonopore. At that time, only species of *Nematopagurus* A. Milne-Edwards and Bouvier, 1892, and *"Pagurodes" limatulus* Henderson, 1888 (subsequently reassigned to *Michelopagurus* McLaughlin, 1997) were known to have sexual modifications in both sexes. McLaughlin (1988) reasoned that *Pagurus piercei* could not be assigned to *Nematopagurus* because of the structure of the male sexual tube, which was long and distally filiform, rather than short and "stubby". Although *Pagurus piercei* and *Pagurodes limatulus* agreed in the form of the sexual tube and the female paired first pleopods, McLaughlin (1988) considered them not to be congeneric because the gills of *Pagurus piercei* were biserial, the chelipeds were grossly unequal and the ambulatory dactyls relatively short. In contrast, the gills of *Pagurodes limatulus* were quadriserial, the chelipeds were subequal and the ambulatory dactyls relatively long.

In addition to the chelipeds being grossly unequal in *Goreopagurus piercei*, the right cheliped was distinctively sexually dimorphic. The carpus in small males and females was somewhat broader than the elongate chela, but with increased size, the male carpus developed a marked flare of the dorsomesial margin, the dorsal surface doubled or tripled in breadth, the lateral face became appreciably produced ventrally and the ventral surface became noticeably concave. The chela became correspondingly more elongate, while surface and marginal spination was reduced.

McLaughlin and Haig (1995) described a second species from the eastern Pacific. Although paired first pleopods were present in females, the male right sexual tube was distinctly shorter in *G. garthi* McLaughlin and Haig, 1995, and the left tube, if developed at all, was even shorter. Despite this difference in sexual tube development, McLaughlin and Haig had no difficulty in assigning their new species to *Goreopagurus*, because the dimorphic right cheliped, while not identical to that of *G. piercei*, was morphologically very similar and showed comparable changes in the carpus and chela in large males. Mature males of the Tasmanian species, *Goreopagurus poorei*

sp. nov. exhibit the same development and dimorphism of the right cheliped, but have no trace of sexual tube development. Additionally, the gills in the new species are distally quadriserial (Fig. 1a), whereas the gills of both *G. piercei* and *G. garthi* are biserial. Nevertheless, in all other morphological attributes, *G. poorei* agrees well with the generic diagnosis. The genus is herein emended to accommodate this new species.

Shield length is measured from the tip of the rostrum to the midpoint of the posterior margin of the shield. The ratio of corneal diameter to ocular peduncle length was obtained by measuring the length of the left ultimate peduncular segment, including the cornea along the lateral surface; corneal diameter was the maximum measured width of the left cornea. Sexual tube lengths are based on the criterion proposed by McLaughlin (2003). The holotype and most paratypes are deposited in Museum Victoria, Melbourne, Australia (NMV); three paratypes have been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM).

Goreopagurus McLaughlin, 1988

Emended diagnosis. Eleven pairs of biserial or distally quadriserial phyllobranchiate gills. Ocular acicles triangular, with prominent submarginal spine, separated basally by basal width or more of 1 acicle. Antennal peduncle with supernumerary segmentation. Maxillule with internal lobe moderately well developed and provided with 1 or 2 stiff distal bristles; external lobe produced, not recurved. Third maxilliped with well developed crista dentata and prominent accessory tooth; merus with or without dorsodistal and ventral marginal spines. Sternite of third maxillipeds with or without small spine on either side of midline.

Right cheliped with elongate, slender chela; propodal-carpal articulation generally perpendicular. Carpus tending to be strongly produced ventrally, at least in large males, dorsomesial margin slightly to prominently expanded. Left cheliped appreciably shorter than right; chela slender, triangular in cross-section; propodal-carpal articulation perpendicular. Sternite of third pereopods with anterior lobe variable in shape. Fourth pereopods with propodal rasp consisting of single row of corneous scales; dactyl with or without preungual process. Fifth pereopods chelate. Sternite of fifth pereopods consisting of 2 ovate or subcircular lobes.

Mature males with coxae of fifth pereopods generally symmetrical; gonopore of right without or with vas deferens produced as short sexual tube; gonopore of left without or with vas deferens produced as very short tube or papilla; 3 unpaired uniramous or weakly biramous pleopods developed on left side of abdominal somites 3–5, very rarely vestigial pleopod on somite 2. Females with paired gonopores; well developed, paired and modified first pleopods; 4 unpaired pleopods, second to fourth unequally biramous, fifth with endopod rudimentary or absent.

Abdomen flexed. Uropods asymmetrical. Telson with transverse indentations; posterior lobes symmetrical or slightly asymmetrical; separated by small median cleft; terminal margins oblique or straight, each armed with few to several small spines; lateral margins frequently delimited by narrow chitinous plate.

Goreopagurus poorei sp. nov.

Figures 1–3

Michelopagurus n. sp.—Koslow and Gowlett-Holmes, 1998: 32.
Michelopagurus sp.—Poore et al., 1998: 71.

Material examined. Holotype. Australia, Tasmania, 84 km SSE of SE Cape, "J1" seamount, 44°16.2′S, 147°19.8′E, 1300 m, 27 Jan 1997 (CSIRO stn SS01/97 37), NMV J44757 (male, 5.2 mm).

Paratypes. Australia, Tasmania, off Freycinet Peninsula, 41°58.6′S, 148°38.9′E, 500 m, 27 Jul 1986 (stn SLOPE 47), NMV J17433 (2 males, 3.6, 4.2 mm). 85.4 km SSE of SE Cape, "Main Pedra" seamount, 44°15.6′S, 147°06.0′E, 741 m, 21 Jan 1997 (CSIRO stn SS01/97 03), NMV J44807 (5 males, 2.9–3.6 mm); NMV J44767 (2 ovigerous females, 2.4, 2.7 mm). 83.8 km SSE of SE Cape, "J1" seamount, 44°16.2′S, 147°19.8′E, 987 m, 27 Jan 1997 (stn SS01/97 36), NMV J448051 (male, 2.4 mm; ovigerous female, 2.6 mm); USNM 1007889 (female, 3.7 mm). 84.0 km SSE of SE Cape "J1" seamount, 44°16.2′S, 147°19.8′E, 1300 m, 27 Jan 1997 (stn SS01/97 37), NMV J52355 (3 males, 3.3–4.9 mm; ovigerous female, 3.2 mm). 85.8 km SSE of Cape, "B1" seamount, 44°18.6′S, 147°16.2′E, 1150 m, 28 Jan 1997 (stn SS01/97 43), NMV J448021 (male, 3.0 mm). 69.7 km SSE of SE Cape, "Mackas" seamount, 44°12.6′S, 147°02.4′E, 640 m, 29 Jan 1997 (stn SS01/97 50), NMV J44808 (male, 3.0 mm). 65.5 km SSE of Cape, SE "Andys" seamount, 44°10.8′S, 147°00.0′E, 800 m, 29 Jan 1997 (stn SS01/97 56), NMV J44804 (5 males, 2.9–4.7 mm), USNM 1007890 (2 males, 2.6, 3.9 mm). 65.1 km SSE of Cape, SE "Andys" seamount 44°10.8′S, 146°59.4′E, 900 m, 29 Jan 1997 (stn SS01/97 57), NMV J44809 (male, 3.0 mm).

Other material. Australia, Tasmania. 66.5 km SSE of Cape, SE "Andys" seamount, 44°11.4′S, 148°57.0′E, 620 m, 29 Jan 1997 (stn SS01/97 55), NMV J44806 (2 males, 2.9, 3.4 mm). 65.6 km SSE of Cape, SE "Andys" seamount, 44°10.8′S, 147°00.0′E, 800 m, 29 Jan 1997 (stn SS01/97 56), NMV J44764 (ovigerous female, 2.6 mm). Exact locality not recorded (CSIRO cruise 1/97), NMV J44810 (male, 2.4 mm; 3 ovigerous females, 2.4–3.3 mm).

Description. Gill lamellae distally quadriserial (Fig. 1a). Shield (Fig. 1b) as broad or broader than long; anterior margins between rostrum and lateral projections weakly concave; anterolateral margins sloping or slightly terraced; posterior margin roundly truncate, frequently with slight median concavity; dorsal surface with few sparse tufts of setae. Rostrum (Fig. 1b–d) acutely or obtusely triangular, with or without small terminal spine or spinule, sometimes also with 1 small spine or spinule laterally on one side. Lateral projections obtusely triangular, each with small submarginal spine.

Ocular peduncles 0.4–0.6 length of shield, moderately stout and with distinct medial constriction; dorsomesial surface with 2 or 3 short, transverse rows of stiff setae in distal half, 1 sparse tuft of setae on dorsal surface; corneal diameter 0.4–0.5 of peduncular length. Ocular acicles narrowly and acutely triangular, with strong submarginal spine; separated basally by at least basal length of 1 acicle.

Antennular peduncles overreaching distal margins of corneas by at least entire length of ultimate segments. Ultimate segment with row of long, stiff setae at dorsodistal margin and additional few scattered, short setae. Penultimate segment with few scattered setae. Basal segment with slender spine on lateral margin of statocyst lobe.

Antennal peduncles overreaching distal corneal margins by

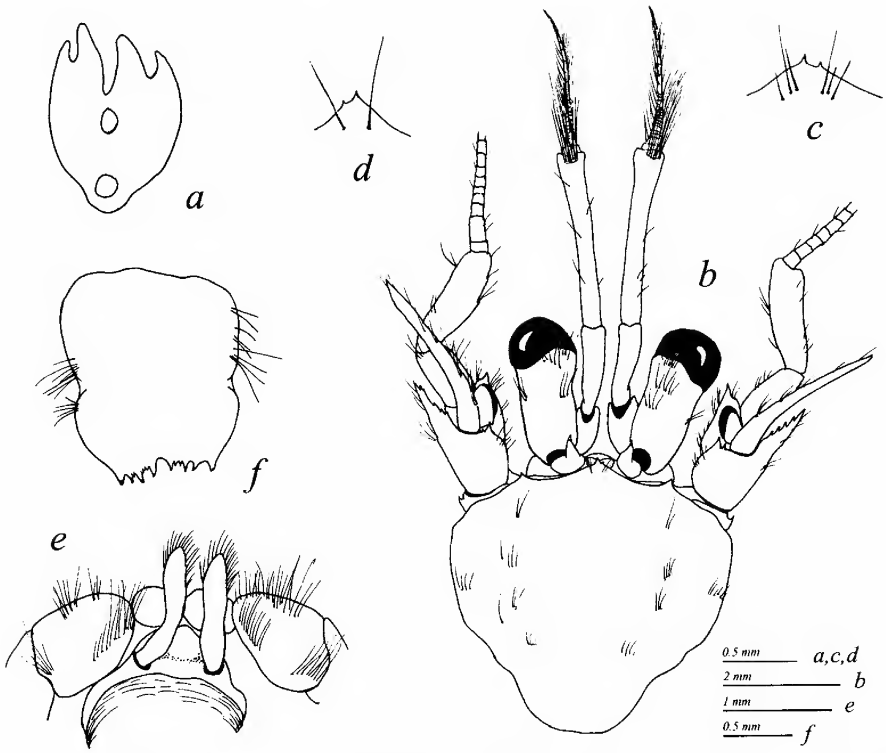

Figure 1. *Goreopagurus poorei* sp. nov.: paratypes: a–c, f, male (3.9 mm), USNM 1007889; d, male (sl =2.6 mm), USNM 1007890; e, female (3.7 mm), USNM 1007889. a, gill lamella; b, shield and cephalic appendages, dorsal view; c, d, rostrum, dorsal view; e, female coxae, eight thoracic sternite, and first abdominal somite with paired pleopods, ventral view; f, telson, dorsal view.

0.7 to entire length of ultimate segments. Fifth segment with several sparse tufts of setae. Fourth segment with few scattered setae. Third segment with prominent, acute spine at ventrodistal margin. Second segment with dorsolateral distal angle produced, terminating in acute spine, mesial margin with 3–7 small spines or spinules (occasionally only weakly apparent) and usually with 1 prominent spine on lateral margin in distal half; dorsomesial distal angle with well developed spine. First segment usually with small spine on dorsolateral distal margin and 1 spine on ventrolateral margin distally. Antennal acicle long, reaching beyond midlength of ultimate peduncular segment, arcuate, terminating in small spine; mesial surface with row of tufts of stiff setae. Antennal flagella long, but usually not overreaching tip of outstretched right cheliped; articles each usually with 2 or 3 short (< length of 1 article) setae.

Third maxilliped with 2 or 3 spines on basis; ischium with accessory tooth on well developed crista dentata; merus with 1 spine on ventral margin and 1 spine at dorsodistal margin. Sternite of third maxillipeds with tiny spinule on either side of midline.

Right cheliped (Fig. 2a–e) of large males very elongate, somewhat shorter in females and small males; palm, fixed finger and dactyl slender, dorsoventrally compressed. Dactyl 0.7–0.9 length of palm; cutting edge with 1 moderately prominent calcareous tooth at midlength, 3 or 4 smaller calcareous teeth proximally and row of very small corneous teeth in distal 0.3, terminating in small corneous claw, but often worn; dorsomesial margin with row of very small spines, spinules or spinulose tubercles, dorsal surface somewhat elevated in midline, occasionally unarmed but usually with single or double row of very small spinules, tubercles or protuberances. Palm slightly shorter than carpus; dorsomesial margin not distinctly delimited, rounded mesial face with irregular rows of very small tubercles, granules or spinules; dorsolateral margin with row of very small spinules, dorsal surface with covering of very small spinules or granules and very short setae, most prominent in females and small males, occasionally additional short row of slightly larger spinules or granules adjacent to dorsolateral margin proximally, dorsal midline with 1 or short, longitudinal row of 2–4 small spines proximally; cutting edge of fixed finger with entire calcareous margin in proximal half, usually few individual calcareous teeth distally, terminating in corneous claw, often worn. Carpus (Fig. 2b, c, e) longer than merus, produced ventrally, particularly in large males; dorsomesial margin weakly to notably expanded, armed with row of prominent, blunt or acute spines, dorsodistal margin with 1 or 2 spines mesially, dorsal surface usually with numerous very small tubercles, granules or low protuberances and scattered setae, dorsolateral margin usually delimited at least distally by row of small granules or spinules; mesial face usually sloping, often

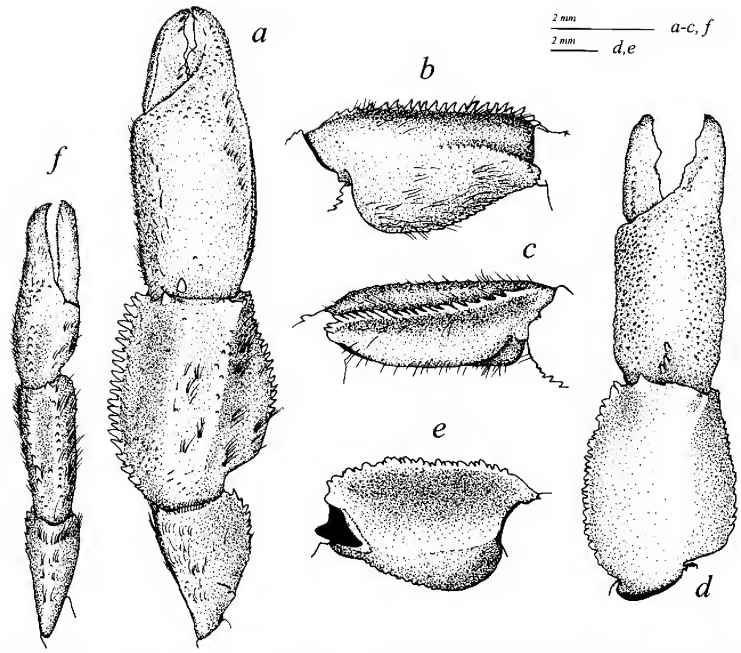

Figure 2. *Goreopagurus poorei* sp. nov.: a–c, f, paratype male (3.9 mm), USNM 1007890; d, e, holotype male (5.2 mm), J44757. a, merus, carpus and chela of right cheliped, dorsal view; b, carpus of same, lateral view; c, same, mesial view; d, carpus and chela of right cheliped, dorsal view; e, carpus of same, ventromesial view; f, merus, carpus and chela of left cheliped, dorsal view.

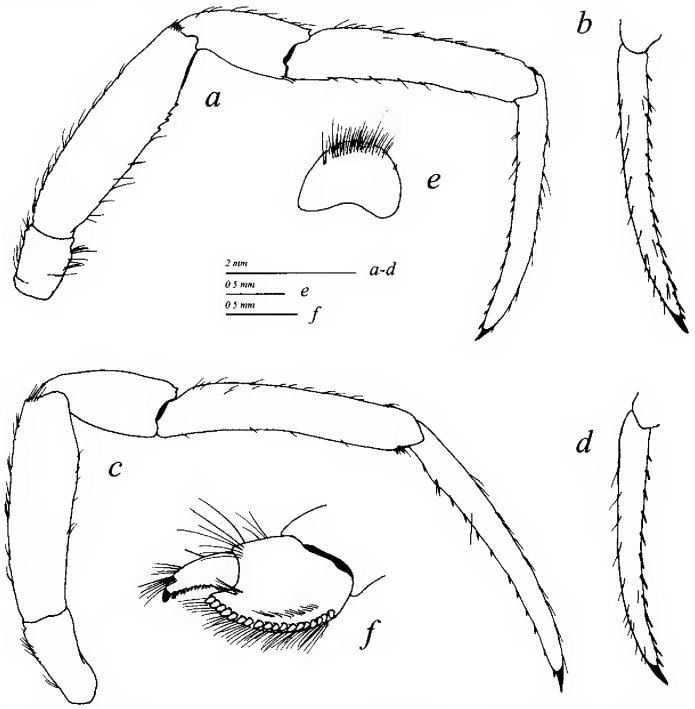

Figure 3. *Goreopagurus poorei* sp. nov.: paratype male (3.9 mm), USNM 1007890. a, second right pereopod, lateral view; b, dactyl of same, mesial view; c, third right pereopod, lateral view; d, dactyl of same, mesial view; e, anterior lobe of sternite of third pereopods, ventral view; f, propodus and dactyl of left fourth pereopod, lateral view.

appearing somewhat concave, ventromesial margin unarmed; ventrolateral margin with row of granules, tubercles or spines. Merus subtriangular; dorsodistal margin sometimes with 1 spine, dorsal surface with few low protuberances and setae; ventromesial and ventrolateral margins each with row of spines, ventral surface usually with few scattered spines and sparse, moderately long setae. Ischium with row of small spinules on ventromesial margin, at least proximally, and scattered moderately long setae.

Left cheliped (Fig. 2f) long and slender, but not reaching much beyond proximal margin of palm of right in large males; dactyl and fixed finger weakly arched ventrally. Dactyl 1.5–2.0 length of palm; cutting edge with row of tiny corneous teeth, terminating in small corneous claw; dorsal surface elevated in midline and with sparse row of setae; dorsomesial margin with irregular row of small spinules or tubercles, at least in proximal half. Palm 0.4–0.6 length of carpus; dorsomesial margin with irregular row of small spines or tubercles, dorsal surface usually with covering of very short setae, midline prominently elevated and armed with row of small spines, extending onto fixed finger but usually not to tip, dorsolateral margin with row of small spinules or granules, adjacent dorsal surface granular; ventral surface with scattered tufts of long setae; cutting edge of fixed finger with row of very small calcareous teeth, interspersed distally with corneous teeth. Carpus slightly shorter to slightly longer than merus; dorsal surface somewhat flattened, dorsomesial and dorsolateral margins each with row of spines, strongest distally; mesial face with numerous protuberances and setae, distomesial margin with few spinules ventrally, sometimes extending onto ventromesial margin; ventral surface with few spinules or low protuberances and scattered, moderately long setae; lateral face unarmed, ventrolateral margin with row of spines. Merus subtriangular; dorsal surface with few low protuberances and sparse setae; ventromesial and ventrolateral margins each with row of spines and moderate to long setae, ventral surface frequently with moderately dense covering of short setae. Ischium with row of small spines or spinules on ventromesial margin and scattered moderately long setae.

Ambulatory legs (Fig. 3a–d) similar from left to right. Dactyls 1.2–1.4 length of propodi; dorsal margins each with sparse row of short stiff setae; ventral margins each with row of 10–13 corneous spines; lateral faces each with weak longitudinal sulcus; mesial faces each with row of corneous spinules dorsally. Propodi 1.3–1.7 length of carpi; each with 1 or 2 corneous spinules at ventrodistal angle and row of widely-spaced, small corneous spinules on ventral margin, dorsal surfaces each with low protuberances and sparse stiff setae or bristles. Carpi each with small spine at dorsodistal margin, few stiff setae arising from low protuberances on dorsal surface, 1 or 2 stiff setae on ventral margin distally and occasionally also medially. Meri with low protuberances and sparse tufts of setae on dorsal surfaces, tufts of stiff setae and occasionally 1 to few, often spinulose, protuberances or small spinules on ventral surfaces, distal angles of second pereopods occasionally each with acute spine (not present in holotype). Ischia unarmed but with few stiff setae or bristles. Anterior lobe of sternite of third pereopods (Fig. 3e) subsemicircular with stiff bristles on anterior margin. Fourth pereopods (Fig. 3f) with small preungual process at base of claw.

Males without sexual tube on either coxa of fifth pereopods; unpaired left pleopods 3–5 with endopods rudimentary, very rarely with vestigial second pleopod present. Females with paired and modified first pleopods (Fig. 1e); second to fourth unpaired left pleopods with endopods stout, egg-bearing, exopods long, slender and usually non egg-bearing; fifth pleopod as in males. Uropods markedly asymmetrical. Telson (Fig. 1f) with transverse indentation; posterior lobes separated by moderately shallow median cleft, terminal margins slightly oblique to nearly horizontal, each with 3–5 small spines, lateral margins sometimes delimited by narrow chitinous band.

Colour (in preservative). Cephalothorax, carpi and meri of chelipeds and entire ambulatory legs with tint of reddish-orange; chelas dirty-white. Ocular peduncles dull red.

Distribution. Tasmania, off Freycinet Peninsula and seamounts SSE of Southeast Cape: "Andys", "B1", "J1", "Main Pedra", and "Mackas" seamounts; 500–1300 m depth.

Etymology. For Gary C. B. Poore, Curator of Crustacea at Museum Victoria, Melbourne, Australia, in recognition of his major contributions to crustacean systematics.

Remarks. On the basis of a few individuals, this species was tentatively but incorrectly assigned to *Michelopagurus* by P.A. McLaughlin in correspondence to Koslow and Gowlett-Holmes (1998).

Individuals of *Gorepagurus poorei* are significantly larger than those of *G. piercei* and *G. garthi*. Specimens range in shield length from 2.4 to 5.2 mm, whereas the specimens of *G. piercei* and *G. garthi*, all sexually mature and including some ovigerous females recorded by McLaughlin (1988) and McLaughlin and Haig (1995) range from 0.5 to 1.8 mm, and 1.3 to 2.3 mm, respectively. McLaughliin (1988) and McLaughlin and Haig (1995) attributed variation of the right cheliped, particularly the carpus, of *G. piercei* and to some extent also *G. garthi*, to sexual dimorphism. Although specimens of *G. poorei* as small as those of *G. piercei* and *G. garthi* are not known, it appears that in *G. poorei* variations of the carpus are related to allometric growth rather than sexual dimorphism. The dorsomesial margin of the carpus in large specimens of *G. poorei* develop a more marked flare (Fig. 2a–d) than in smaller specimens; the strength and sharpness of the spines on the dorsomesial and ventrolateral margins of the carpus diminish with increased size.

Not only is *G. poorei* immediately distinguishable from *P. piercei* and *P. garthi* by the absence of male sexual tubes, the gill lamellae are distally quadriserial rather than biserial. Although uniformity in gill structure is usual in most genera, *Goreopagurus* is not the only genus in which both biserial and distally quadriserial gills are found. A similar condition exists in the parapagurid genus *Sympagurus* (Lemaitre, in press: fig. 1) and the pagurid *Xylopagurus* A. Milne-Edwards, 1880 (pers. obs.). McLaughlin and de Saint Laurent (1998) reported that gill lamellae vary from deeply quadriserial to only distally so within a single species or even within a single individual. De Saint Laurent-Dechancé (1966) considered quadriserial gills

more primitive than biserial gills, thus one might envision the evolution of the gill lamellae from completely divided to distally divided to entire (biserial). In the case of the three species of *Goreopagurus*, the most primitive species then would be *G. poorei*. Support for this hypothesis is also apparent in the transition from no sexual tubes in *G. poorei* to very short tubes in *G. garthi* to short tubes in *G. piercei*.

Sexual tube development and its role in systematics of Paguroidea

H. Milne Edwards (1837) described specialised tubular structures found on the coxae of the fifth pereopods in a species of the semiterrestrial hermit crab genus *Coenobita* Latreille, 1829. De Haan (1849) described an apparently similar structure in the pagurid, *Pagurus spiriger* De Haan, 1849, a species subsequently transferred to the genus *Spiropagurus* Stimpson, 1858. Although these tubular structures on the coxae of male pagurids and coenobitids were recognised by early carcinologists (e.g., Stimpson, 1858; Miers, 1881; Henderson, 1888; A. Milne-Edwards and Bouvier, 1892, 1893; Borradaile, 1903; Alcock, 1905), it was de Saint Laurent-Dechancé (1966) and de Saint Laurent (1968, 1970a, 1970b) in particular who discussed their role in the systematics of Paguridae. Importantly, she pointed out that early classifications had placed species in genera on the basis of tube position, without consideration of other characters, and as a result, species with disparate morphologies often were assigned to the same genus. At that time, only eight genera had been described with male sexual tubes. There are now many more (McLaughlin, 2003) and the number has increased dramatically in the past 35 years.

Two types of sexual tubes can be differentiated, although most descriptions make no distinction. Those in several, but not all, species of *Coenobita* represent prolongations of the coxae that are heavily calcified, and are diagnostic at the specific level (Nakasone, 1988). In contrast, sexual tubes in Paguridae are diverse and may be coxal prolongations or external prolongations of the vas deferens that may be calcified, chitinous or membranous. Their development and form have had a major, although not always informed, impact on classification at the generic level. McLaughlin's (2003) key to genera emphasises the length and direction of sexual tubes but there are many instances where intrageneric variation requires alternative pathways. Her figures 7h–t illustrate the varibility.

De Saint Laurent (1968, 1970a, 1970b) was of the opinion that just the presence or position of tubes was not indicative of close phylogenetic relationships. McLaughlin and Lemaitre (2001), and Lemaitre and McLaughlin (2003) emended the diagnoses of *Pylopagurus* A. Milne-Edwards and Bouvier, 1891, *Enallopaguropsis* McLaughlin, 1981, and *Enallopagurus* McLaughlin, 1981, to indicate minor sexual tube development in some species. Their rationale was that members of each genus shared suites of other morphological characters. In contrast, Komai (1998, 1999) transferred four species from *Pagurus* to *Parapagurodes* McLaughlin and Haig, 1973 simply because males were found to have very short sexual tubes. As a result, the presence of a right sexual tube is the only commonly shared character among these species currently assigned to *Parapagurodes*. On the basis of cheliped morphology and other attributes, *P. gracilipes* (Stimpson, 1858) and *P. nipponensis* Yokoya, 1933 appear most closely related to McLaughlin's (1974) "*bernhardus*" group of *Pagurus*. Similarly *Parapagurodes imalli* (Yokoya, 1939) and *P. constans* (Stimpson, 1858), while not immediately identifiable with specific groups within *Pagurus*, are not phylogenetically related to the species for which the genus *Parapagurodes* was proposed. This view is also supported by the larval data of Hong and Kim (2002) for *P. constans*.

Correspondingly, Asakura (2001: 827) transferred *Catapagurus doederleini* Doflein, 1902 to *Parapagurodes*, stating that Doflein's (1902) species agreed in all diagnostic characters with McLaughlin and Haig's (1973) genus. Yet Asakura (2001: 888) pointed out how the structure of the ambulatory legs of *P. doederleini* differed from all species presently included in *Parapagurodes*. Additionally, there are marked differences in telson structure of *P. doederleini* and all of the other assigned species. The only shared character of any potentially phylogenetic significance is the presence in *P. doederleini*, as in the other species, of a very short right sexual tube and a slight protrusion of the vas deferens from the left gonopore. We concur with Asakura's conclusion that Doflein's (1902) species is not assignable to *Catapagurus* or *Hemipagurus* as redefined; however, its inclusion in *Parapagurodes* is equally inappropriate.

Our only precise information on the structure and function of hermit crab sexual tubes is the recent study by Tudge and Lemaitre (2003) of *Micropagurus acantholepis* (Stimpson, 1858), a species with a moderate to long (> 2 coxal lengths) left sexual tube. These authors demonstrated that a well developed sexual tube is used in the transport of spermatophores and described the ultrastructure. Sexual tube structure is just one of a number of morphological characters that should be considered when making generic evaluations.

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A new genus and species of hermit crab (Decapoda: Anomura: Paguridae) from seamounts off south-eastern Tasmania, Australia

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Abstract McLaughlin, P.A. 2003. A new genus and species of hermit crab (Decapoda: Anomura: Paguridae) from seamounts off south-eastern Tasmania, Australia. *Memoirs of Museum Victoria* 60(2): 229–236.

A new and highly variable species, representing a new genus of hermit crabs, is described and illustrated. In addition to the morphological changes in shape and armature of the chelipeds associated with growth in *Bythiopagurus macrocolus*, gen. nov., sp. nov., this species exhibits a singular development of the left chela that may be an adaptation to its specialised habitat among colonies of the stony coral *Solenosmilia variabilis* Duncan. The similarities seen among the genera *Bythiopagurus*, gen. nov., *Michelopagurus* McLaughlin and *Icelopagurus* McLaughlin appear the be superficial and convergent; *Bythiopagurus* appears phylogenetically related to the *Pylopaguropsis* group of genera characterised by 13 pairs of bi- or quadriserial gills.

Key words Crustacea, Anomura, Paguridae, new genus, new species, Tasmania, seamounts, *Bythiopagurus*

Introduction

The seamount region of south-eastern Tasmania is a distinctive deep-water environment extensively surveyed for the first time between 20 January and 1 February 1997. Among the approximately 242 species of invertebrates cited by Koslow and Gowlett-Holmes (1998) in their report on the survey, only three were hermit crabs. Two of the three were new to science. *Propagurus deprofundis* (Stebbing, 1924), described initially from South Africa, was reported by McLaughlin and de Saint Laurent (1998) to range from South Africa to Hawaii, and had been collected previously in Tasmanian waters (McLaughlin, unpub.). Of the latter two, the species of *Goreopagurus* described by Lemaitre and McLaughlin (2003) is the first truly deep-water record (620–1300 m) for this genus, and the first report of the genus outside the continental waters of Atlantic and Pacific coasts of the United States. The unusual species reported herein represents both a new species and a new genus that is noteworthy not only for its characteristic growth-related variability, but for its unusual habitat. It was found only in association with colonies of the stony coral, *Solenosmilia variabilis* Duncan, 1873.

Measurements include shield length, measured from the tip of the rostrum to the midpoint of the posterior margin of the shield. However, in this genus, as in a few others, e.g. *Goreopagurus* McLaughlin, 1988, *Alainopaguroides* McLaughlin, 1997, the shield breadth: length ratio increases appreciably with increased animal size, thus making the measurement of shield length less informative than for most pagurid genera. The ratio was calculated of corneal diameter (maximum measured width of the left cornea) to length of the ocular peduncle (length of the left ultimate peduncular segment, including the cornea, along the lateral surface). Male sexual tube development varies from a simple papilla-like protrusion to very short (less than coxal length) tube(s), but occasionally the vas deferens may not be extruded at all. The holotype and most paratypes are deposited in Museum Victoria, Melbourne, Australia (NMV); and three paratypes in the National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (USNM).

Terminology. For the most part, the terminology utilised in the species description follows that of McLaughlin (1997) but the interpretation of gill structure is based on the definition of Lemaitre (in press). The varying extent to which the paguroid cephalothorax is delineated and/or calcified has resulted in a certain amount of confusion regarding the correct terminology to be applied to various portions (e.g. Boas, 1880, 1926; Bouvier, 1895; Borradaile, 1906; Jackson, 1913; Pilgrim, 1973; McLaughlin, 1974; Forest, 1987). Morgan and Forest (1991) corrected the misinterpretation by McLaughlin (1974) regarding the sulcus cardiobranchalis and assigned the name cardiac sulci to the previously unnamed sulci bordering the posteromedian plate. Lemaitre (1995) added another term "accessory portion" for the calcified portion of the carapace presumably delineated anteriorly by the cervical groove and posteriorly by

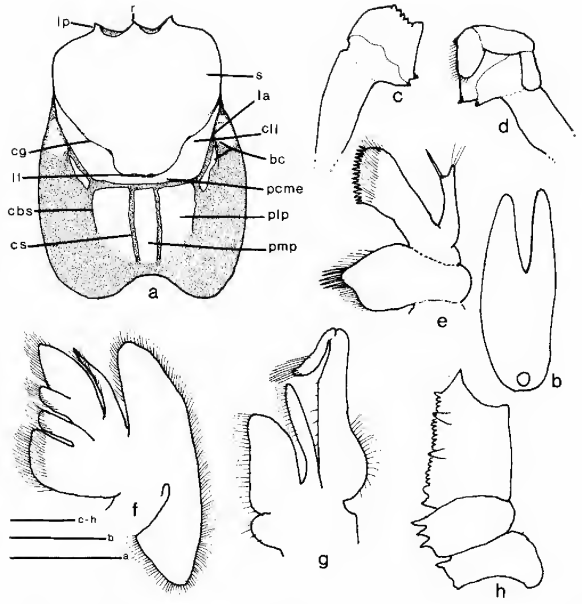

Figure 1. *Bythiopagurus macrocolus*, gen. nov., sp. nov.: a,♂ paratype (6.4 mm), USNM 1007810; b–h, ♀ paratype (6.0 mm), J44760: a, cephalothorax; b, gill lamella; c, left mandible (internal view, palp removed); d, right mandible (internal view); e, left maxillule (external view, setal details omitted); f, left maxilla (external view, setal details omitted); g, left maxilliped 1 (external view, setal details omitted); h, coxa, basis and ischium of left maxilliped 3 (external view, setae omitted). Abbreviations: bc: branchiostegal areas of calcification; cbs: sulcus cardiobranchialis; cg: cervical groove; cll: carapace lateral lobe; cs: cardiac sulcus; la, linea anomurica; lp: lateral projection; lt: linea transversalis; pcme: posterior carapace median element; plp: posterolateral plate; pmp: posteromedian plate; r: rostrum; s: shield. Scales equal 1 mm (b–h) and 5 mm (a).

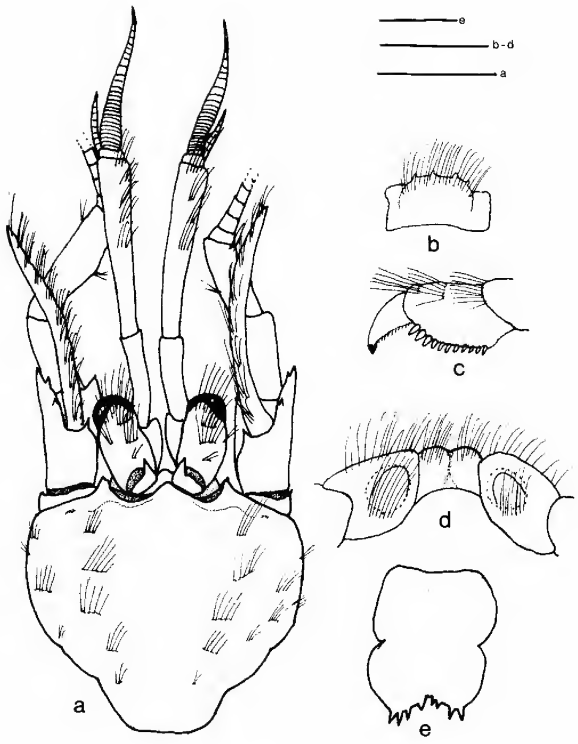

Figure 2. *Bythiopagurus macrocolus*, gen. nov., sp. nov.: a–d, ♂ paratype (6.4 mm), USNM 1007810; e,♂ holotype (6.0 mm), J44765. a, shield and cephalic appendages (dorsal view, aesthetascs omitted); b, anterior lobe of sternite of pereopods 3; c, dactyl and propodus of left pereopod 4 (lateral view); d, coxae and sternite of pereopods 5; e, telson. Scales equal 3 mm (a), 2 mm (b–d) and 1 mm (e).

the linea transversalis. These calcified areas have now become incorporated into species descriptions as "accessory portion of the shield" (e.g. Asakura, 2001; McLaughlin and Lemaitre, 2001). Personal examination of the internal structure of the cephalothorax of *Propagurus deprofundis*, *Porcellanopagurus tridentatus* Whitelegge, 1900, *Solitariopagurus triprobolus* Poupin and McLaughlin, 1996 and the new species have confirmed the structure and position of the linea transversalis as defined by Boas (1926) and Pilgrim (1973). The linea transversalis is a chitinous hinge separating the posterior portion of the shield from the median anterior portion of the posterior carapace. It does not curve anteriorly to delineate areas of calcification as illustrated by McLaughlin (1974: fig. 2), Lemaitre (1995: fig. 1), or McLaughlin and Lemaitre (2001: fig. 2); nor is it calcified as reported by McLaughlin (1997) and Asakura (2001). Although its position can be recognised externally, the linea transversalis itself often is not visible on the surface of the carapace and may be covered by a calcified plate.

In *Bythiopagurus macrocolus* gen. nov., sp. nov., the shield is completely delineated from the surrounding well calcified integument by the cervical groove (Fig. 1a), much as it is in the genera *Porcellanopagurus* Filhol, 1885 and *Solitariopagurus* Türkay, 1986 (cf. McLaughlin, 2000: fig. 1). The linea transversalis in *B. macrocolus* is contiguous with the cervical groove centrally and delimits the calcified lateral elements posteriorly on either side of the posterior margin of the shield. In this respect, the linea transversalis of *B. macrocolus* is comparable to that of *Porcellanopagurus*, which directly abuts the posterior carapace lobes. However, the carapace is not broadened in *B. macrocolus* as it is in *Porcellanopagurus* and *Solitariopagurus*, thus the lateral calcified elements do not appear posterior as they tend to in the latter genera, particularly in *Solitariopagurus*. Nevertheless, these calcified elements cannot correctly be considered accessory portions of the shield, because by definition, the shield is delimited by the cervical groove (Forest, 1987: 18). Despite the positional homologies in the three genera, the anterolateral position of these calcified areas in *Bythiopagurus* necessitate that they be referred to as carapace lateral lobes (Fig. 1a) rather than posterior carapace lateral lobes. It would appear that these carapace lateral lobes are partially delimited anterolaterally by the linea anomurica, but these lineae are difficult to follow posteriorly in the membranous regions of the branchiostegites. Other terminology applied to the elements of the posterior portions of the

carapace follow those used by McLaughlin (2000) for *Porcellanopagurus* and *Solitariopagurus*.

Bythiopagurus gen. nov.

Type species. Bythiopagurus macrocolus sp. nov.

Diagnosis. Shield and carapace lateral lobes well calcified; posterior carapace with posterior carapace element contiguous or fused with lateral carapace lobes, posteromedian and posterolateral plates also well calcified at least in anterior halves (Fig. 1a). Sulci cardiobranchialis extending approximately 0.50 length of posterior carapace; cardiac sulci extending nearly to posterior margin. Cervical groove distinct; linea transversalis usually partially discernable externally; linea anomurica not readily apparent in posterior portion of carapace. Frequently small areas of branchiostegal regions weakly calcified .

13 pairs of distally quadriserial (Fig. 1b) phyllobranchiate gills.

Ocular peduncles short and stout; ocular acicles acutely triangular. Antennal peduncles with supernumerary segmentation.

Mandibles sometimes weakly asymmetrical (Fig. 1c, d); strongly calcified; palp well developed. Maxillule (Fig. 1e) with anterior lobe of endopod weakly developed, posterior lobe moderately well developed, not recurved. Maxilla (Fig. 1f) with slender scaphognathite. First maxilliped (Fig. 1g) with slender two-segmented exopod; no epipod. Third maxilliped with basis and ischium not fused; crista dentata of ischium well developed (Fig. 1h), 1 or 2 accessory teeth.

Chelipeds subequal; left sometimes longer, but not stronger; dactyls and fixed fingers opening in horizontal plane. Fourth pereopod very weakly semichelate; propodal rasp consisting of single row of corneous scales (Fig. 2c). Fifth pereopod chelate. Male usually with papilla or very short sexual tube extruded from both right and left gonopores (Fig. 2d). Female with paired gonopores.

Abdomen somewhat reduced, dextrally twisted. Male with left unpaired pleopods on somites 3–5; exopods moderately long and very slender, endopods reduced. Female with paired and modified pleopod 1, unpaired left pleopods 2–4 with both rami of approximately equal length, endopods much thicker; pleopod 5 as in male.

Uropods markedly asymmetrical. Telson with transverse indentations; posterior lobes separated by median cleft; terminal margins each with few small spines.

Etymology. From Greek *bythios* meaning from the deep, and *pagurous* meaning crab, and referring to the archibenthic and archiabyssal depths from which the type species was collected.

Bythiopagurus macrocolus sp. nov.

Figures 1–3

Paguridae n. gen. n. sp.— Koslow and Gowlett-Holmes, 1998: 30 (in part, see remarks).

Pagurid sp.—Poore, et al., 1998: 71 (in part, see remarks).

Material examined. Holotype. ♂ (6.0 mm), NMV J44765, CSIRO SS01/97 stn 41, 44°19.2′S, 147°07.2′E, 1083 m; 82.8 km SSE of SE Cape "U" seamount, Tasmania, Australia.

Paratypes. All from Tasmanian seamounts, collected on cruise CSIRO SS01/97. Stn 15, 82.9 km SSE of SE Cape "Sister 1", 44°16.2′S, 147°17.4′E, 1100 m, 23 Jan 1997, 6 ♂ (2.6–5.9 mm), 9 ♀ (3.2–6.4 mm), 5 ovigerous ♀ (4.2–6.2 mm), NMV J44760. Stn 28, 89.5 km SSE of SE Cape "K1", 44°17.4′S, 147°24.6′E, 1225 m, 25 Jan 1997, 4 ♂ (4.3–6.8 mm), 1 ovigerous ♀ (3.6 mm), NMV J44762. Stn 34, 85.4 km SSE of SE Cape "U", 44°19.8′S, 147°10.2′E, 1083 m, 27 Jan 1997, 3 ♀ (4.2–5.3 mm), NMV J44759. Stn 37, 84.0 km SSE of SE Cape "J1", 44°16.2′S, 1477°19.8′E, 1300 m, 27 Jan 1997, 1 ♂ (4.9 mm), 1 ♀ (4.2 mm), 1 ovigerous ♀ (6.2 mm), NMV J44803. Stn 40, 82.6 km SSE of SE Cape "J1", 44°14.4′S, 147°21.8′E, 1200 m, 27 Jan 1997, 2 ♂ (4.4, 5.1 mm), 5 ♀ (5.1–6.4 mm), 5 ovigerous ♀ (sl = 5.1–6.3 mm), NMV J44758. Stn 41, 82.8 km SSE of SE Cape "U", 44°19.2′S, 147°07.2′E, 1083 m, 27 Jan 1997, 1 ♂ (4.2 mm), 1 ♀ (4.3 mm), 3 ovigerous ♀ (5.0–5.5 mm), NMV J44765; 2 ♂ (3.8, 6.4 mm), 1 ovigerous ♀ (5.3 mm), USNM 1007810. Stn 58, 81.2 km SSE of SE Cape "38", 44°13.2′S, 147°22.8′E, 1140 m, 30 Jan 1997, 1 ♂ (5.6 mm), NMV J44768. Stn 59, 81.6 km SSE of SE Cape "38", 44°13.8′S, 147°22.8′E, 1200 m, 30 Jan 1997, 1 ♂ (4.5 mm), NMV J44763. Stn 62, 87.8 km SSE of SE Cape "A1", 44°19.8′E, 147°16.2′E, 1200 m, 30 Jan 1997, 1 ovigerous ♀ (5.4 mm), NMV J44761.

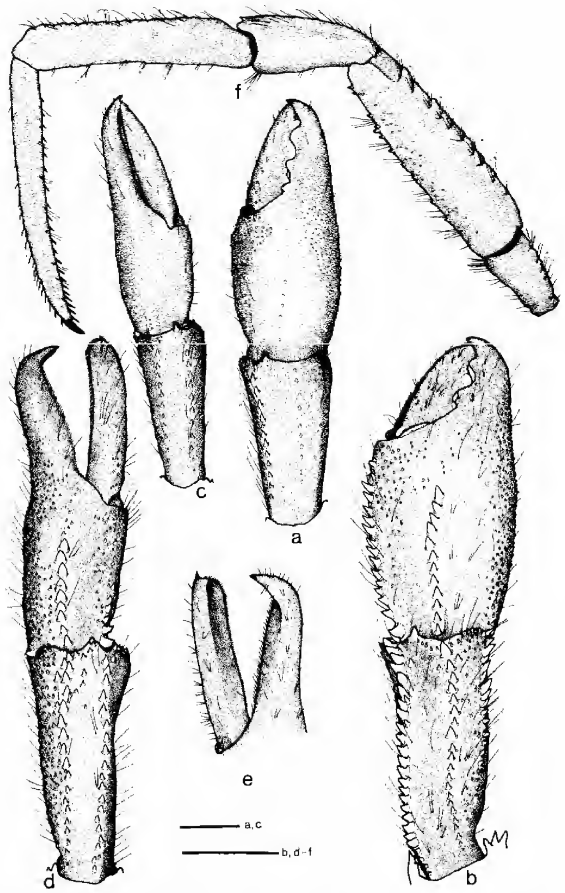

Figure 3. *Bythiopagurus macrocolus*, gen. nov., sp. nov.: a, c, ♂ paratype (2.6 mm), J44760; b, d–f, ♂ paratype (6.4 mm), USNM 1007810. a, b, chela and carpus of right cheliped (dorsal view); c, d, chela and carpus of left cheliped (dorsal view); e, dactyl and fixed finger of left chela (ventral view); f, left pereopod 2 (lateral view). Scales equal 5 mm (b, d–f) and 1 mm (a, c).

Other material examined. CSIRO SS91/97, no other data, 1 (5.6 mm), NMV J44801.

Description. Shield (Figs. 1a, 2a) broader than long; anterior margin between rostrum and lateral projections concave; anterolateral margins sloping; posterior margin truncate; dorsal surface with numerous sparse tufts of simple setae. Rostrum triangular, reaching to or slightly beyond bases of ocular acicles; with or without terminal spinule. Lateral projections reaching level of rostrum or slightly beyond, each with prominent marginal or submarginal spine.

Ocular peduncles very short and stout, 0.40–0.50 length of shield; dorsal, mesial and lateral surfaces calcified, median longitudinal region of ventral surface membranous; dorsal surfaces of peduncles each with 3 or 4 short transverse rows of simple setae; corneas reduced dorsally by projection of peduncular integument, corneal diameter 0.40–0.50 of peduncular length. Ocular acicles each with slender triangular projection, terminating acutely and with small submarginal spine or spinule not usually visible dorsally; separated basally by approximately 0.50 basal width of 1 acicle.

Antennular peduncles overreaching distal margins of corneas by length of ultimate segments to nearly entire lengths of penultimate segments. Ultimate segments nearly twice length of penultimate segments, dorsal surfaces each with 3–5 short transverse rows of simple setae. Penultimate segments with few sparse tufts of setae. Basal segments each with slender spine on dorsolateral margin of statocyst lobe.

Antennal peduncles overreaching distal margins of corneas by entire lengths of fifth and fourth segments, but reaching only to approximately midlength of ultimate segments of antennular peduncles. Fifth and fourth segments with few sparse tufts of short setae. Third segment with spine at ventrodistal margin. Second segment with dorsolateral distal angle prominently produced, terminating in small spine and with 1 or 2 small spines on mesial margin; dorsomesial distal margin with well developed spine. First segment sometimes with spine on dorsolateral distal margin, ventrolateral margin with 1 spine. Antennal acicles reaching to or nearly to distal margin of fifth peduncular segment, terminating in small spine; mesial margin with row of sparse tufts of stiff setae.

Mandibles with upper incisor edge of left (Fig. 1c) with 2 to several calcareous denticles, cutting edge with corneous-tipped tooth at lower angle, sometimes also at upper angle, stout internal ridge presumably representing molar process with usually corneous-tipped tooth at lower angle; right mandible with upper edge of incisor process (Fig. 1d) unarmed or with 1 or 2 calcareous denticles, upper and lower angles of cutting edge each usually with corneous-tipped tooth, presumed molar process with usually corneous-tipped tooth at lower angle; palp three-segmented, distal segment with row of short marginal setae. Maxillule (Fig. 1e) with internal lobe of endopod not produced, but provided with 1 stiff bristle, external lobe somewhat produced, not recurved, with 3 terminal setae. First maxilliped (Fig. 1g) with setae of external margin of exopod only on proximal half. Third maxilliped (Fig. 1h) with prominent tooth at ventrodistal angle of coxa; basis with 2 or 3 spine-like teeth on ventral margin; ischium with well developed crista dentata, usually 1 or occasionally 2 widely separated accessory teeth; merus and carpus each with dorsodistal spine.

Right cheliped (Figs 3a, b) long and slender. Dactyl 0.50 to nearly equal to length of palm; dorsomesial margin not delimited, rounded mesial face unarmed or with numerous minute spinules in proximal half; dorsal surface often with scattered small pits and individual or sparse tufts of short to moderately long setae; ventral surface with scattered tufts of longer setae; cutting edge usually with 2 or 3 large calcareous teeth, terminating in small corneous claw and slightly overlapped by fixed finger, occasionally crossed with fixed finger in larger specimens. Palm 0.70–0.95 length of carpus; armature of dorsomesial margin varying from ill-defined and irregular single or double row of small spinules or tubercles over entire length in small specimens to row of prominent spines in proximal 0.80–90 of margin and small spines or spinules in distal 0.10–0.20 in large individuals; dorsal surface with scattered very small tubercles or spinules, particularly in mesiodistal 0.35, dorsal midline with longitudinal row of 6–13 tiny to prominent spines, not extending to junction of dactyl and fixed finger; dorsolateral margin not delimited except faintly in some small specimens, but armed with numerous very small and tiny spinules, tubercles or granules, extending to distal 0–25–0.50 of fixed finger; mesial, lateral and ventral surfaces with tiny tubercles or spinules, sometimes forming short, transverse rows; surfaces all with scattered sparse tufts of short to moderately long setae, most numerous ventrally; cutting edge of fixed finger with 2 or 3 prominent calcareous teeth, calcareous ridge or sometimes few to several small calcareous teeth distally. Carpus slightly shorter to slightly longer than merus; dorsomesial margin with row of small to moderately prominent spines, dorsodistal margin usually with 1 small to large spine mesially and several very small spines laterally, occasionally only single small spine in small specimens; dorsal midline with row of small spines or spinules becoming row of prominent spines in large individuals, dorsolateral surface sloping, dorsolateral margin armed with weakly defined row of tiny spinules or tubercles in small specimens, increasing in size and number with increased body size; mesial and lateral faces each with scattered to moderately dense covering of very small tubercles or spinules, most numerous in small individuals, distal margins each sometimes with several spines or spinulose tubercles; ventromesial margin often tuberculate, ventral surface with scattered tubercles; ventrolateral margin usually not delimited, but with 1 or 2 spines at ventrolateral distal angle. Merus subtriangular; dorsal surface with row of short transverse ridges and sparse tufts of setae; mesial face with few sparse tufts of setae, ventromesial margin with row of conical, subacute spines, ventral surface often with scattered spines; ventrolateral margin not distinctly delimited but with short transverse rows of small tuberculate spines extending onto ventral surface. Ischium with row of small spines or spinules on ventromesial margin, ventral surface with few low protuberances or small spines and sparse setae. Coxa with spine on distal margin ventromesially and additional spine ventrolaterally.

Left cheliped (Figs 3c–e) often as long as or slightly longer than right; dactyl approximately 0.50 longer than palm; dorsal

surface slightly elevated proximally, dorsomesial margin not delimited, but with transverse tuberculate or minutely spinulose ridges and sparse setae, few spinules on dorsal surface in proximal half, dorsal surface also with scattered stiff setae; cutting edge with row of small corneous spines, rounded tip of dactyl slightly overlapped by corneous claw of fixed finger (Fig. 2c) in small specimens (e.g. 2.6 mm), just beginning to show overlap by fixed finger (e.g. ovigerous ♀ 3.6 mm), or completely overlapped by hooked end of fixed finger (Figs 2d, e) in large specimens (e.g. 3.5 mm, ♀ 5.0 mm); inner surface of dactyl concave, small corneous claw laterally positioned at tip of dactyl. Palm 0.65–0.80 length of carpus; dorsomesial margin variable: not delimited in small specimens, but rounded surface frequently armed with numerous tiny spinulose tubercles or small spines often increasing in size proximally and tufts of setae; large specimens with well delimited margin armed with row of small spines not quite extending to distal margin, 1 or 2 prominent spines at proximal angle; dorsal surface elevated in midline and armed with row of 3–11 minute to moderately prominent tuberculate spines, not reaching to articulation of dactyl, but often continued as irregularly-set very small spinules in large individuals; dorsomesial surface unarmed in small specimens, but with increasing number of small or very small spinules with increased size, primarily in distal half; dorsolateral surface sloping and armed with numerous minute to small spinules and/or tubercles, continued onto proximal half of fixed finger, dorsolateral margin varying from well delimited by row of small spines to not delimited, but rounded surface with numerous tiny to small spinules or spinulose tubercles also continued onto fixed finger but not extending to tip, dorsolateral proximal angle with blunt tubercle or spine; ventral surface with small spinules or spinulose tubercles laterally, remainder of ventral surface with tufts of sparse setae; distal portion of fixed finger curved and slightly overlapping dactyl in small specimens, but becoming drawn out into hook-like tip with increased size, terminating in small corneous claw; inner surface of fixed finger oblique in small individuals to prominently concave, particularly distally in larger specimens. Carpus slightly shorter to approximately equal to length of merus; dorsodistal margin with 1 to several small spines; dorsomesial margin with irregular row of small to moderately large spines, dorsal surface often with few small spines, at least distally and tufts of sparse setae, irregular row of small to moderately large spines beginning proximally at dorsolateral angle but becoming almost median distally in larger specimens because of sloping dorsolateral surface; in smaller specimens lateral face tending to be more perpendicular, surface armed with numerous tiny to small spinules or tubercles, ventrolateral margin delimited by row of small spines or simply rounded with surface armature continued onto ventral surface laterally; mesial face with scattered tufts of sparse setae, distomesial margin and mesial surface ventrally spinulose or tuberculate; remainder of ventral surface with few low protuberances and tufts of sparse setae. Merus subtriangular; dorsal surface with short transverse rows of sparse setae; ventromesial margin with row of irregularly-sized spines; ventrolateral margin with row of somewhat smaller spines, lateral face ventrally with short transverse rows of very small tubercles or granules accompanied by tufts of setae; ventral surface with few small spines, particularly laterally, and scattered tufts of sparse setae. Ischium with row of small spines on ventromesial margin, 1 small spinule on ventrolateral margin distally, ventral surface occasionally with few scattered small spines. Coxa with spine on ventromesial distal margin and additional spine on distal margin ventrolaterally.

Ambulatory legs (Fig. 3f) similar from left to right, usually only slightly overreaching tips of chelipeds, if at all. Dactyls 0.10–0.30 longer than propodi; dorsal surfaces each with row of tufts of moderately short sparse setae, interspersed with corneous spinules in distal 0.25–0.45; lateral faces generally flattened, each with faint longitudinal sulcus flanked dorsally and ventrally by row of sparse setae; mesial faces each with weak longitudinal sulcus and row of corneous spinules dorsally; ventral margins each with row of 15–23 corneous spines; terminating in sharp corneous claw. Propodi 0.50–0.70 longer than carpi; dorsal surfaces each with low protuberances and numerous tufts of sparse setae; lateral faces each usually with row of tufts of sparse setae dorsally; ventral surfaces each with few tufts of sparse setae, 1 or 2 corneous spines on each ventrodistal margin, at least on second. Carpi each with small dorsodistal spine; dorsal surfaces with few low, occasionally weakly spinulose, protuberances and tufts of sparse setae; lateral faces each with row of sparse setae dorsally; ventral surfaces each with 2 or 3 tufts of setae. Meri each with transverse ridges and sparse setae dorsally; ventral margins of second pereopods each with irregular row of small spines and tufts of sparse setae, lateral faces often with few to numerous spinules or granules in lower half; third with ventral margins usually unarmed, rarely with few minute spinules or granules, but with scattered tufts of setae. Ischia each with dorsal and ventral tufts of setae. Anterior lobe of sternite of third pereopods (Fig. 2b) subrectangular, anterior margin with 1 or 2 pairs of small subacute or acute spines.

Telson (Fig. 2e) with posterior lobes symmetrical or only weakly asymmetrical; terminal margins somewhat oblique, each armed with 1 or 2 to several spines.

Colour (in preservative). Cephalothorax and appendages all generally orange to reddish-orange.

Reproduction. Slightly more than half of the females collected were ovigerous, but few if any of the eggs were near to hatching (eyed). The eggs were relatively small (diameter 0.75–0.98 mm) and quite numerous, although precise counts were not possible because of obvious loss during preservation and transport.

Variation. Variation in shape and armature of the chelipeds is appreciable in *B. macrocolus* as is indicated in the description, and this appears to be a function of size rather than sexual dimorphism. Small specimens of both sexes do not have the prominent spines on the dorsomesial margin of the right chelae (Fig. 3a) or on the dorsomesial margins of the right and left carpi seen in large specimens. Similarly, the median row of spines on the right chela becomes increasingly more pronounced with increasing animal size. In contrast, the row of spines often delimiting the dorsolateral margin of the chela of the right in small individuals becomes indistinguishable in larger specimens. The very unusual development of the dactyl

and fixed finger of the left cheliped may be an adaptation to its distinctive environment; however, it is unquestionably correlated with animal growth. In the smallest specimen (♂2.6 mm) the corneous claw of the fixed finger overlaps the rounded tip of the dactyl (Fig. 3c) but the terminal portion of the fixed finger has not yet developed into a hook. The ventral surfaces of the dactyl and fixed finger, while sloping inward in this small male, do not exhibit the prominent concavities seen in larger individuals (Fig. 3e). Although these morphological variations are seen in both sexes, there appears to be a developmental "lag" in females. In males and females of similar size, spination on the dorsomesial margins of chela and carpi tends to be more prominent in males, whereas the loss of marginal distinction dorsolaterally on the chela occurs more rapidly.

Distribution and habitat. Seamounts U, J1, K1, A1, 38 and Sister 1 off south-eastern coast of Tasmania; 1083–1300 m; typically occupying small gastropod shells; found in association with primarily dead colonies (Gowlett-Holmes, 1998: 47) of stony coral, *Solenosmilia variabilis*.

Etymology. From Greek *makros*, meaning long, and *kolon* meaning leg, and indicative of the long-leggedness of this hermit crab.

Remarks. Because size-related diagnostic characters are not apparent in small specimens, individuals of shield lengths <2.8 mm, particularly females, *Goreopagurus poorei* Lemaitre and McLaughlin, 2003 look superficially like small *B. macrocolus*. Consequently, specimens reported by Koslow and Gowlett-Holmes (1998: 21) from "Andys" and "Main Pedra" seamounts and Poore et al. (1998: 77) from stations 03, 06, and 56 were incorrectly referred to *B. macrocolus*. Two lots, one from "Andys" (stn 56) and one from "Main Pedra" (stn 03), are *G. poorei*. The single female (4.2 mm) from "Main Pedra" seamount (stn 06) belongs to *Pagurodes inarmatus* Henderson, 1888, which shares with the aforementioned species distinctly shortened ocular peduncles.

The majority of specimens of *B. macrocolus* had been removed from their shells shortly after capture but a few examined still occupied shells. These shells were worn and frequently damaged but the most notable observation was that the shells rarely even completely covered the abdomens of the crabs. Correspondingly, there appeared to be reduction in overall abdomen length with increased animal size. The need for only minimal abdominal protection is undoubtedly correlated with the appreciable calcification of the cephalothorax of *B. macrocolus* as it is in species of *Labidochirus* Benedict, 1892, *Porcellanopagurus*, and *Solitariopagurus*. Whether a similar correlation exists between abdomen length and shell size cannot be adequately determined from the limited material.

Discussion

Certain morphological characters shared by *Bythiopagurus* and *Icelopagurus* McLaughlin, 1997 might suggest a relationship between the two. Both monotypic genera are defined as having broad, well calcified anterior carapaces, very short ocular peduncles, long antennular and antennal peduncles and elongate chelipeds and ambulatory legs. However, that the similarities are superficial and not phylogenetic is clearly apparent when gill number and structure, mandibular and maxillulary development, male and female secondary sexual characters and telsonal structure are considered. *Bythiopagurus* has 13 pairs of distally quadriserial gills, whereas *Icelopagurus* has 11 biserial pairs. The mandibles, or at least the left, has a denticulate upper margin in *Bythiopagurus*, while this margin is smooth in *Icelopagurus*. The external lobe of the endopod of the new genus is produced but it is rudimentary or vestigial in *Icelopagurus*. Papillae or very short male sexual tubes usually are produced from both gonopores in *Bythiopagurus* but the right sexual tube in *Icelopagurus* is of moderate length (> 2 coxal lengths) and directed toward the exterior. Females of the new genus have pleopod 1 paired and modified; no first pleopod development occurs in females of *Icelopagurus*. The very distinctive telson, which is armed on the terminal margin of each posterior lobe with several long corneous spines sets *Icelopagurus* apart from all other genera.

Papillae or paired, very short sexual tubes, paired and modified female pleopod 1, quadriserial gill structure, development of the external lobe of the endopod of the maxillule, short stout ocular peduncles, and subequal chelipeds are characters that *Bythiopagurus* shares with *Michelopagurus* McLaughlin, 1997, and these characters certainly might suggest more than a superficial relationship. That the gills are only distally divided in the new genus and deeply divided in the latter genus is of little significance. McLaughlin and de Saint Laurent (1998) found that gill lamellae in their genus, *Propagurus*, varied from biserial to distally quadriserial within a single gill of *P. deprofundis*. Lemaitre (2003b) has shown that in species of *Sympagurus* Smith, 1883 considerable variation occurs in the extent of lamellar division, both within and among species. More important is the fact that there are 13 pairs of gills in *Bythiopagurus*, but only 11 in *Michelopagurus*. Other characters also indicate that the observed similarities most probably are convergent. Perhaps most significant are the major differences in cephalothoracic calcification among species of the two genera, the dentition on the mandible(s) in *Bythiopagurus*, and the lack of fusion between the basis and ischium of the third maxilliped in the latter genus.

De Saint Laurent-Dechancé (1966) considered those few genera of Paguridae that have 13 pairs of gills to be the most primitive genera. At the time of her report, only five genera, *Munidopagurus* A. Milne-Edwards and Bouvier, 1893, *Xylopagurus* A. Milne-Edwards, 1880, *Pylopaguropsis* Alcock, 1905, *Tomopaguropsis* Alcock, 1905, and *Tomopaguroides* Balss, 1912, were included in her *Pylopaguropsis*-group although she was aware of additional undescribed genera. In addition to gill number, this group of genera was characterised by the presence of an accessory tooth on the crista dentata of maxilliped 3, by paired first and/or second pleopods in males or paired pleopod 1 in females, but with males lacking sexual tubes.

Since de Saint Laurent-Dechancé's (1966) discussion of relationships among genera of Paguridae, an additional 41 genera have been described, of which only five can be included in her *Pylopaguropsis*-group: *Lithopagurus* Provenzano, 1968, *Bathypaguropsis* McLaughlin, 1994, *Propagurus*, *Chano-*

pagurus Lemaitre, 2003a, and *Bythiopagurus*. All have 13 pairs of gills but pleurobranchs of the fifth and sixth thoracic somites (cephalothoracic somites XI and XII, McLaughlin and Lemaitre, 2001) are reduced or rudimentary in *Chanopagurus* and *Propagurus*. De Saint Laurent-Dechancé (1966: 259) was of the impression that all genera in the *Pylopaguropsis*-group had quadriserial gills but Asakura (2000) has demonstrated that the gills in species of *Pylopaguropsis* are really biserial. The gills in *Lithopagurus* and *Munidopagurus* are also reported to be biserial (McLaughlin, 2003). Lemaitre (1995) had described the gills of *Xylopagurus* as biserial whereas McLaughlin (2003) indicated that both bi- and quadriserial gills occurred in species of that genus. Lemaitre (pers. comm.) has now found that gills in species of *Xylopagurus* vary from very weakly divided distally (practically biserial) to distally divided (quadriserial).

With the exception of *Tomopaguroides* where the crista dentata has not been described, all have an accessory tooth; however, there may be one or two teeth in *Bythiopagurus*. The mandible has been described as having a denticulate upper margin only in *Bythiopagurus* and *Pylopaguropsis* but in the former genus, the incisor process usually is provided with small corneous-tipped teeth. A truly corneous-toothed incisor process has been described only in the Pylojacquesidae McLaughlin and Lemaitre, 2001 but even calcified individual teeth are rare in Paguroidea.

Males of *Xylopagurus* have both pleopods 1 and 2 paired, whereas only pleopod 2 is paired in *Lithopagurus* and *Tomopaguroides*. Males of *Chanopagurus* are unknown, but in none of the remaining six genera are either pleopods 1 or 2 paired, although unpaired pleopods may or may not be present. Contrary to de Saint Laurent-Dechancé's (1966) diagnosis of the *Pylopaguropsis*-group, males of *Bythiopagurus* do have extruded papillae or very short sexual tubes. As noted by Lemaitre and McLaughlin (2003), whether the presence of very short sexual tubes or simple papillae reflects an early stage in evolutionary sexual tube development or is a function of sexual activity in species lacking sexual tube development is not known. Paired female gonopores are characteristic of the *Pylopaguropsis*-group but females of *Chanopagurus* have a single left gonopore. Paired pleopod 1 occurs in females of several genera, but not in *Bathypaguropsis, Lithopagurus, Propagurus*, or *Tomopaguropsis*. Females of *Tomopaguroides* are unknown.

Clearly, the presence of 13 pairs of gills is the single unifying character of the *Pylopaguropsis*-group, as in virtually all other morphological attributes there is extreme diversity. However, for the four genera of the group in which some larval information is available, Provenzano (1971) commented that the several unusual features found in the zoeas of *Pylopaguropsis atlantica* Wass, 1963, *Lithopagurus yucatanicus* Provenzano, 1968, *Munidopagurus macrocheles* (A. Milne-Edwards, 1880), and *Xylopagurus rectus* A. Milne-Edwards, 1880 could not be without phylogenetic significance.

McLaughlin and de Saint Laurent (1998) noted that species of *Propagurus* exhibited morphological variations that suggested this genus was undergoing evolutionary transformations from those of the typical *Pylopaguropsis*-group genera to those seen in *Pagurus*-like genera. In addition to the overall development of gill lamellae that varied from deeply quadriserial to only distally divided, these authors pointed to reduction in the pleurobranch of the fifth thoracic somite and to the development of the external lobe of the maxillulary endopod, which varied from well developed to rudimentary. If the other morphological variations demonstrated among genera of the *Pylopaguropsis*-group are considered in a similar context, it might be possible to develop a model of evolutionary change using this small, and presumably monophyletic, potentially primitive group of pagurids that would be applicable to the larger conglomerate of taxa with 11 or fewer pairs of gills.

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Gnathophyllum taylori, a new species of caridean shrimp from south-eastern Australia (Crustacea: Decapoda: Gnathophyllidae)

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Abstract Ahyong, S. T. 2003. *Gnathophyllum taylori*, a new species of caridean shrimp from south-eastern Australia (Crustacea: Decapoda: Gnathophyllidae). *Memoirs of Museum Victoria* 60(2): 237–242.

A new species of caridean shrimp, *Gnathophyllum taylori* sp.nov., is described from south-eastern Australia. The new species most closely resembles two Atlantic species, *G. modestum* Hay, 1917, and *G. elegans* Risso, 1816, but is readily distinguished by its banded rather than spotted body colour pattern. *Gnathophyllum taylori* is the third Indo-West Pacific species to be recognised. It differs from *G. americanum*, with which it can be sympatric, by having fewer and narrower dark bands on the body as well as by the rostral dentition, morphology of the orbit and dactyli of the walking legs. The identity of *G. fasciolatum* Stimpson, 1860, a junior synonym of *G. americanum*, is fixed by neotype selection.

Keywords Crustacea, Decapoda, Caridea, *Gnathophyllum taylori*, new species

Introduction

The most recent treatment of the caridean genus *Gnathophyllum Latreille*, 1819, recognised eight species worldwide with two in the Indo-West Pacific – *G. americanum* Guérin-Méneville, 1855, and *G. precipuum* Titgen, 1989 (see Chace and Bruce, 1993). *Gnathophyllum precipuum* is known only from Hawai'i. *Gnathophyllum americanum* is presently recognised as having a circumtropical distribution and in the Indo-Pacific is known from the Red Sea and South Africa to Australia, Japan and French Polynesia. Off eastern Australia, *G. americanum* is known as far south as Port Jackson, Sydney, New South Wales. To date, specimens of *Gnathophyllum* from south-eastern Australia have not been studied in any detail but a popular account recognised two colour forms of *G. americanum* from eastern Australia (Healy and Yaldwyn, 1970). One form bears numerous narrow pale bands on a dark background, and the other form bears relatively few, narrow dark bands on a pale background. The first form is *G. americanum* sensu stricto, whereas the second form represents a new species, described below.

Measurements given for each specimen refer to orbital carapace length followed by total carapace length, given in millimetres (mm). Specimens are deposited in the collections of the Australian Museum, Sydney (AM).

Gnathophyllum taylori sp. nov.

Figures 1–2

Gnathophyllum americanum.—Healy and Yaldwyn, 1970: 46, fig. 21.—Debelius and Baensch, 1994: 506 [not *G. americanum* Guérin-Méneville, 1855]

Gnathophyllum sp.—Debelius, 1999: 196 [colour figure].

Material examined. Holotype: AM P64829, ovigerous female (3.9/5.6 mm), S side of Long Bay, Malabar, New South Wales, 33°58′S, 151°15′E, 4 m, under *Centrostephanus rogersi*, R. Taylor, 3 Apr 2001.

Paratypes: AM P306, 2 ovigerous females (5.0/7.0-5.7/7.7 mm), Port Jackson; AM P1420, 3 females (4.2/5.9 mm, 5.4/7.5 mm, ovigerous 6.9/9.3 mm), Port Stephens, 32°42′S, 152°06′E; AM P12423, 1 ovigerous female (4.0/5.7 mm), Long Reef, Collaroy, 33°44′S, 151°19′E, west end of reef among weeds and boulders, low tide, E. Pope, 15 Feb 1953; AM P38007, 1 ovigerous female (3.8/5.5 mm), SW Elizabeth Reef, Tasman Sea, 29°57.7′S, 159°02.8′E, outer slope, among coral heads and overhangs, A. Gill and S. Reader, 11 Dec 1987.

Comparative material of *Gnathophyllum americanum* Guérin-Méneville, 1855. AM P62995, ovigerous female (4.1/5.8 mm), Rose Bay, Port Jackson, NSW, seine net, D. Hoese 19 Jan 1976 (neotype of *G. fasciolatum* Stimpson); AM P20302, 1 male (4.0/5.4 mm), 1 female (4.2/5.7 mm), Gun Island, Houtman Abrolhos Group, Western Australia, 1.8 m, under rocks near reef edge, N. Coleman, 9 May 1972; AM P18558, 1 male (4.2/5.4 mm), 1 ovigerous female (4.3/5.4 mm), Heron Island, Queensland, Aug 1960.

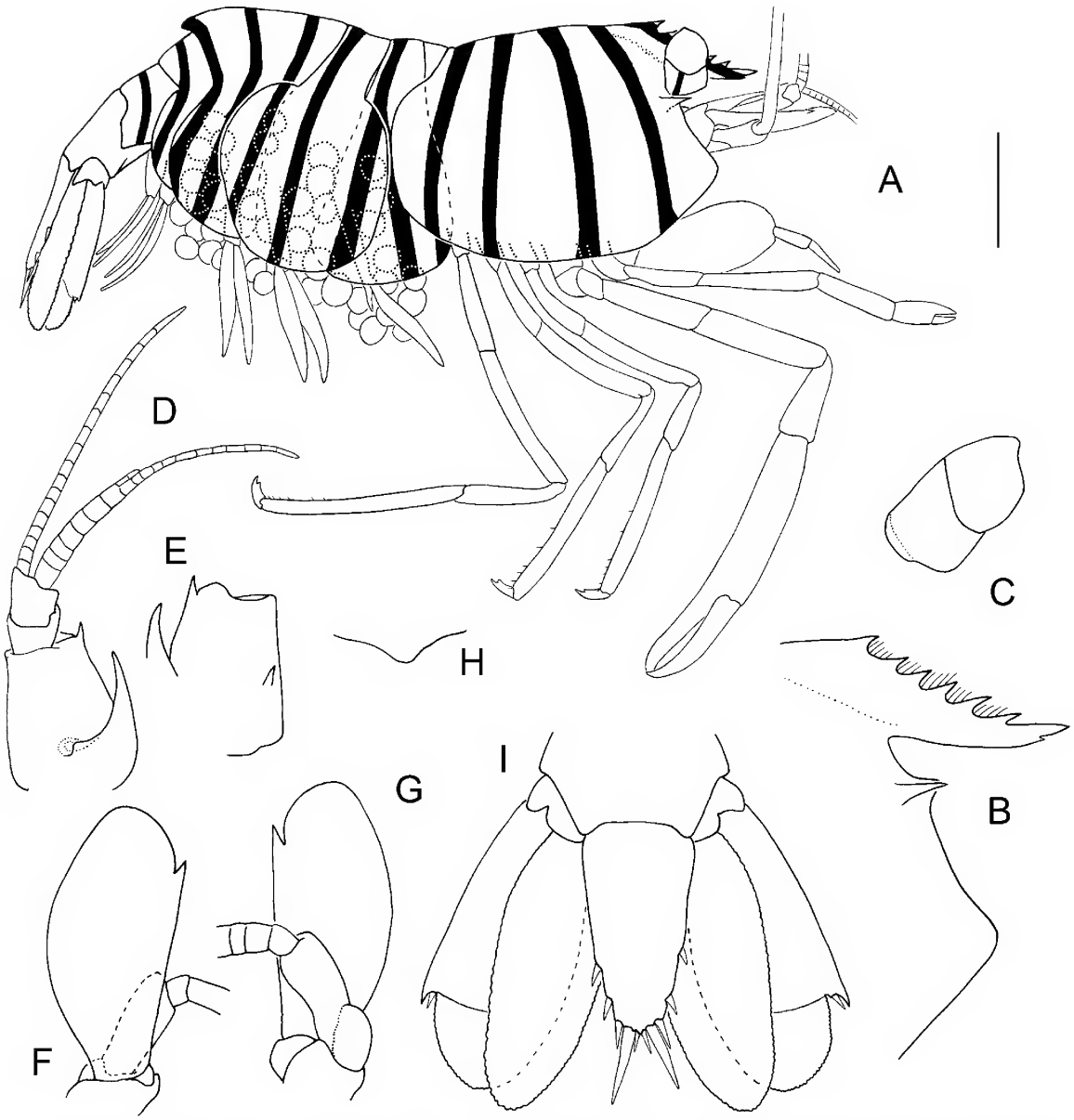

Figure 1. *Gnathophyllum taylori* sp. nov., holotype female cl. 5.6 mm. A, right lateral. B, anterior carapace, right lateral. C, eye, right lateral. D, antennule, right dorsal. E, basal segment of antennule, right ventral. F, antennal peduncle, right dorsal. G, antennal peduncle, right ventral. H, posterior margin of third abdominal somite, dorsal. I, tailfan, dorsal. Scale A = 2 mm, B–I = 1 mm.

Diagnosis. Rostrum with 5 or 6 dorsal teeth and minute subdistal ventral denticle; proximal 1 or 2 teeth behind level of posterior orbital margin. Orbit without narrow posterodorsal sinus. Telson posterior lateral spines arising well anterior to outer pair of posterior spines; telson posterior margin with blunt median tubercle. Cornea of eye with narrow, rounded point. Antennular peduncle with apex of stylocerite not reaching base of second segment. Pereopods 3–5 with dactylus biunguiculate, ventral process shorter than dorsal, broad, subtrapezoid, not evenly tapering. Body pale dull yellow with narrow, widely spaced dark bands; pereopods without banding but with white speckling; sixth abdominal tergite and tail-fan transparent.

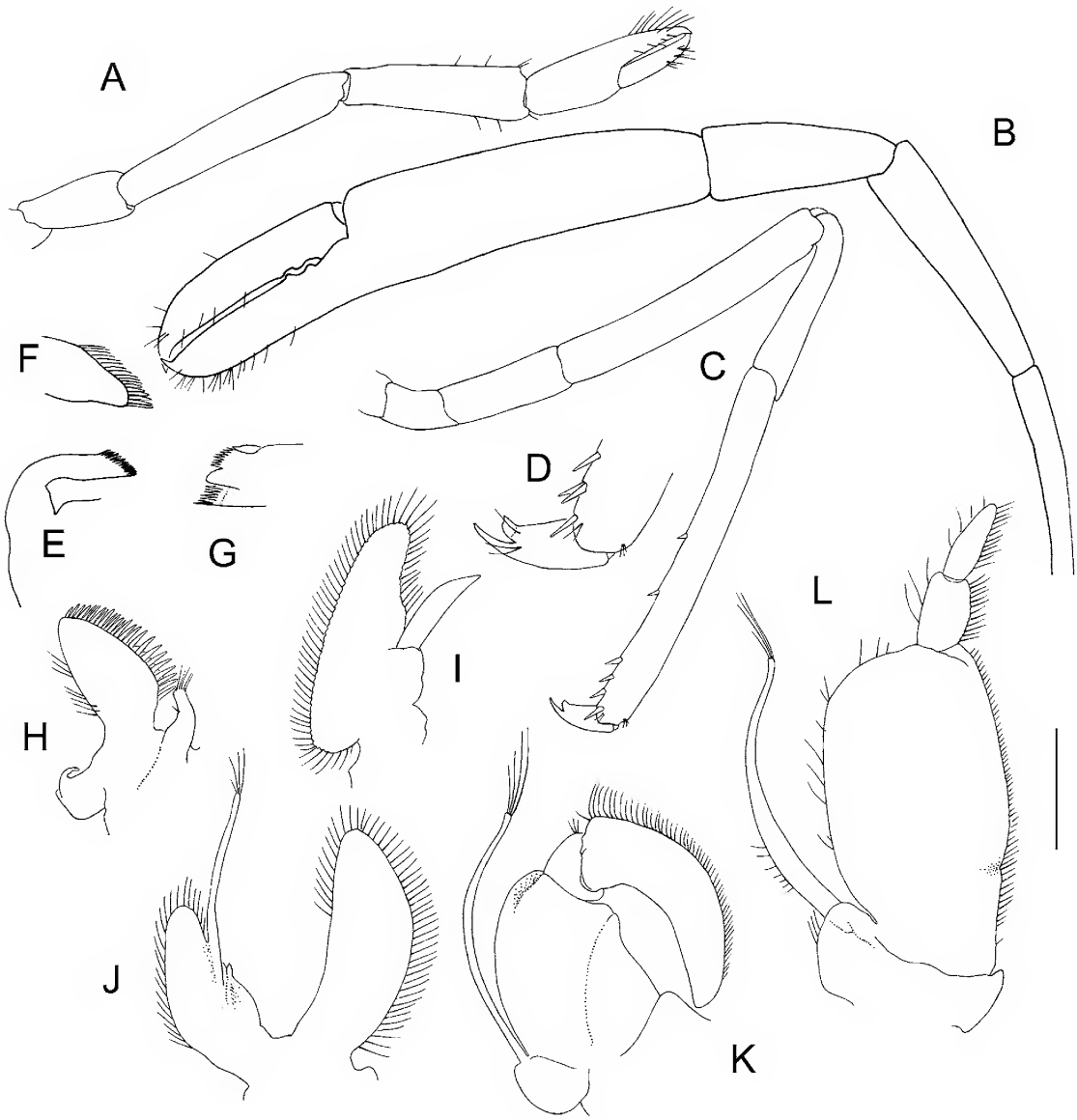

Figure 2. *Gnathophyllum taylori* sp. nov., holotype female cl. 5.6 mm. A, pereopod 1, right lateral. B, pereopod 2, left lateral. C, pereopod 3, right lateral. D, dactylus of pereopod 3, right. E, mandible, right posterior. F, mandible, distal posterior. G, mandible, distal anterior. H, maxilla 1, right posterior. I, maxilla 2, right posterior. J, maxilliped 1, left anterior. K, maxilliped 2, right posterior. L, maxilliped 3, right posterior. Scale A–C, E–L = 1 mm, D = 0.5 mm.

Description. Rostrum not overreaching basal-antennular-segment, with 5 or 6 dorsal teeth and minute subdistal ventral denticle; proximal 1 or 2 teeth behind level of posterior orbital margin. Orbit without narrow posterodorsal sinus. Antennal spine well developed, arising slightly submarginally. Inferior orbital angle with blunt anterior projection at level of antennal spine, extending anteriorly to or slightly beyond apex of antennal spine. Pterygostomian angle of carapace rounded and produced anteriorly beyond antennal spine.

Abdomen smooth, pleura 1–4 rounded; pleuron 5 posterolaterally angular; medial margin of somite 3 rounded, slightly overhanging somite 2. Sixth abdominal somite three-quarters length of telson; height about three-quarters length. Telson twice as long as wide; with 2 pairs of lateral spines and 3 pairs

of spines on posterior margin; anterior lateral spines arising well behind midlength of telson; posterior lateral spines arising well anterior to outer pair of posterior spines; intermediate posterior spines more than twice length of lateral and mesial posterior spines; mesial posterior spines somewhat soft; telson posterior margin with blunt median tubercle.

Cornea of eye pigmented; with blunt apical point.

Antennular peduncle with broad basal segment, apex of stylocerite not reaching base of second segment, with stout distolateral spine overreaching second segment, ventromesial margin with spine at midlength; dorsolateral flagellum totalling 19–28 articles, fused basal portion of 7–13 short articles.

Antennal scale overreaching antennular peduncle; about twice as long as wide; lateral margin straight, distal spine about as long as wide, not reaching to apex of blade.

Mandible small, unequal, without incisor process. Maxillule with upper endite expanded with double row of robust setae medially, setose laterally; lower endite small, blunt, distally setose. Maxilla without endites; scaphognathite well developed, marginally setose; palp elongate, distally tapered, non-setose.

First maxilliped with well developed caridean lobe, exopod slender, distally setose; endite large, setose. Second maxilliped exopod slender, distally setose; endopod with broad basal articles and elongate, curved distal segment, setose on outer margin. Third maxilliped well-developed; endopod with operculiform ischiomerus, about twice as long as wide, evenly setose medially, sparsely setose laterally; exopod long, slender, setose distally and proximolaterally; ischiomerus completely fused with basis.

Pereopods symmetrical left to right. Pereopod 1 distinctly overreaching antennal scale by length of chela and three-quarters length of carpus; occlusal margins of dactylus and pollex smooth; dactylus almost as long as palm. Pereopod 2 overreaching antennal scale by length of chela and carpus; occlusal margins of dactylus and pollex smooth on distal three-quarters sinuous on proximal third; dactylus more than $1^1/_2$ times palm length. Pereopods 3–5 similar, merus 6–7 times as long as wide. Distal half of propodus with 7–10 movable spines along lower margin. Dactylus biunguiculate, dorsal process slender, evenly tapering to sharp point; ventral process shorter than dorsal, broad, trianguloid to subtrapezoid, not evenly tapering.

Uropodal protopod unarmed dorsally or ventrally; exopod with stout laterodistal spine flanked by smaller movable spine mesially; endopod ovate, unarmed.

Colour in life. Body pale dull translucent yellow with narrow, widely spaced dark purplish bands; 4–5 bands on carapace, 6–8 bands on abdomen; margins of dark bands slightly brighter than base colour of body. Ground colour of cephalothorax sometimes appearing deeper yellow than that of abdomen owing to colour of viscera. Pereopods without banding but with white or yellowish speckling. Sixth abdominal somite and tail-fan transparent. Third maxilliped with dark purple "O" on ischiomerus.

Etymology. Named for Richard Taylor, Leigh Marine Laboratory, New Zealand (formerly of University of New South Wales, Australia), who collected the holotype.

Distribution. NSW, Elizabeth Reef south to Long Bay.

Remarks. Gnathophyllum taylori sp.nov. is the third species of the genus to be recognised from the Indo-West Pacific. *Gnathophyllum precipuum*, from Hawai'i is readily distinguished from *G. taylori* by having two instead of five or six dorsal rostral teeth, and by lacking the dark banding on the body. Instead, *G. precipuum* has a basic colour pattern of "irregular reddish-brown spots on light yellow background" (Titgen, 1989: 206). The only other species of *Gnathophyllum* known from the Indo-West Pacific is *G. americanum*. As in *G. taylori*, *G. americanum* bears dark banding on the body, but of a different pattern. Morphologically, however, *G. taylori* most closely approaches the Atlantic species, *G. elegans* (Risso, 1816) and *G. modestum* Hay, 1917, in having the posterior-most of the dorsal rostral spines situated behind the posterior orbital margin, in having the posterior pair of lateral telson spines distinctly anterior to the posterior pair of spines, and in having the apex of the stylocerite not reaching the base of the second antennular segment. The new species is readily distinguished from *G. modestum* and *G. elegans* by the considerably shorter laterodistal spine on the antennal scale in which it is about as long as wide instead of about twice as long as wide. *Gnathophyllum taylori* also differs from *G. modestum* and *G. elegans* by the banded rather than uniform or spotted colour pattern of the body (Manning, 1963).

Both *G. taylori* and *G. americanum* bear transverse banding on the body, but the nature of the banding is the most obvious distinguishing feature. In *G. americanum* the dark bands are broader and about twice as numerous as in *G. taylori*. The broader and more numerous dark bands in *G. americanum* give the body a dark overall appearance whereas in *G. taylori*, the background colour is dull pale yellow with narrow, widely spaced dark purplish bands giving the body a light overall appearance. In addition, the pereopods are banded in *G. americanum*, but not banded in *G. taylori*. The ground colour of the body of *G. taylori* may vary somewhat in the density of pale yellow pigmentation. Where the base pigmentation is less dense, the colour of the internal organs is visible through the carapace giving the appearance of a deeper yellow cast to the cephalothorax as figured by Debelius and Baensch (1994) and Debelius (1999). Conversely, the base yellow pigmentation in the holotype was denser, giving a more uniformly yellow cast to the whole body.

Aside from differences in colour pattern, *G. taylori* differs morphologically from *G. americanum* in having the proximal tooth of the dorsal rostral series on the carapace arising behind instead of anterior to the posterior orbital margin, in having a higher range of dorsal rostral teeth (5 or 6 instead of 3–6), in lacking a short narrow sinus in the posterodorsal margin of the orbit, and in having a broad rather than slender ventral tooth on the dactyli of pereopods 3–5.

A character that might prove useful in distinguishing species of *Gnathophyllum* is the fusion of the ischiomerus with the basis of the third maxilliped. In *G. taylori* and apparently in *G. ascensione* Manning and Chace, 1991 (see their fig. 5P), the ischiomerus and basis of the third maxilliped are fused. Conversely, the ischiomerus and basis appear to be clearly demarcated in *G. americanum* from the Canary Islands and

Micronesia, and *G. precipuum* as figured by Kubo (1940: fig. 8F), Holthuis (1949b: fig. 6H) and Titgen (1989: fig. 2I) respectively. The accuracy of these figures requires verification, but if accurate, indicate that the degree of fusion of the ischiomerus and basis of the third maxilliped has diagnostic value for species of *Gnathophyllum*. It is noteworthy then, that all Australian specimens of *G. americanum* examined resemble *G. taylori* in the fusion of the ischiomerus and basis of the third maxilliped, unlike those figured by Holthuis (1949b) and Kubo (1940). The possible heterogeneity in *G. americanum* also indicates the potential validity of one of its synonyms, *Gnathophyllum fasciolatum* Stimpson, 1860.

Gnathophyllum fasciolatum Stimpson, 1860, was described from Port Jackson, Sydney, which is well within the range of *G. taylori*. Stimpson's (1860) species has long been established as a junior synonym of *G. americanum* (e.g. Rathbun, 1901; Armstrong, 1940; Manning, 1963; Chace and Bruce, 1993). *Gnathophyllum americanum*, first described from Cuba, is presently regarded as a near-cosmopolitan species but could prove to be a species complex (this study, Davie, 2002). The holotype of *G. fasciolatum*, however, is lost and Stimpson's (1860) brief account could apply to either species of *Gnathophyllum* from the Sydney region (let alone almost any other species of the genus were colour pattern not considered). *Gnathophyllum fasciolatum*, an older name, threatens the nomenclatural stability of *G. taylori*. Therefore, a neotype designation for *G. fasciolatum* is justified. A specimen of *G. americanum* from Rose Bay, Port Jackson, is herein designated as the neotype of *G. fasciolatum* to fix the identity of the species (Fig. 3). The neotype is an ovigerous female, cl. 5.8 mm, registered as AM P62995. Revision of *G. americanum* is beyond the scope of this study but should *G. fasciolatum* be removed from synonymy, its identity is now stabilised through the present neotype selection. Other synonyms of *G. americanum* are not identifiable with *G. taylori*. In both *G. zebra* Richters, 1880 (described from Mauritius) and *G. miniscularium* Armstrong, 1940 (described from Bermuda), the posterior-most dorsal rostral tooth is placed anterior to the orbit instead of behind as in *G. taylori*. *Gnathophyllum tridens* (type locality Rikitea, French Polynesia; redescribed by Holthuis, 1949a) bears three dorsal rostral teeth and is within the range of *G. americanum* (3–6) but not of *G. taylori* (5–6). *Gnathophyllum pallidum* Ortmann, 1890, also described from French Polynesia, was neither illustrated nor described in detail, but is well within the known range of *G. americanum*, and well outside that of *G. taylori*.

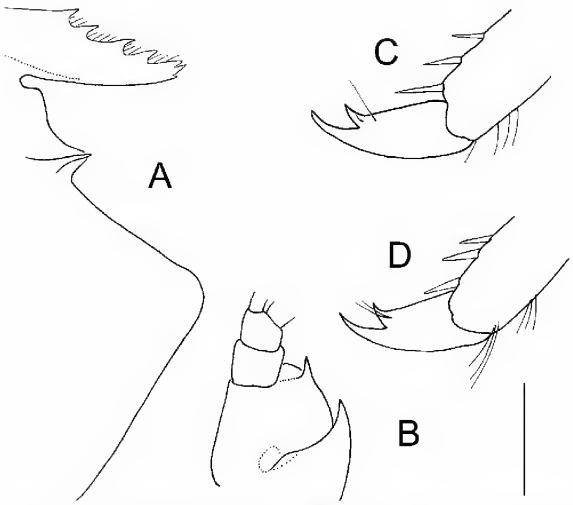

Figure 3. *Gnathophyllum americanum*, (neotype of *G. fasciolatum*), female cl. 5.8 mm. A, anterior carapace, right lateral. B, antennule, right dorsal. C, dactylus of pereopod 3, right. D, dactylus of pereopod 5, right. Scale A, B = 1 mm, C, D = 0.5 mm.

The holotype of *G. taylori* was collected from beneath the echinoid, *Centrostephanus rogersi*, but other specimens were collected from under boulders or amongst marine algae. *Gnathophyllum taylori* is temperate water species, in contrast to the primarily tropical *G. americanum*. All known specimens of *G. taylori* are from New South Wales, Australia. *Gnathophyllum americanum* is known as far south as Port Jackson on the east coast and as far south as the Abrolhos Islands on the west coast. The distribution of *G. taylori* thus overlaps that of *G. americanum* in south-eastern Australia. *Gnathophyllum americanum* was figured in colour from near Grafton and Lord Howe Island, New South Wales by Healy and Yaldwyn (1970: pl. 20), and Coleman (2002: 50) respectively. Debelius and Baensch (1994) and Debelius (1999: 196) figured *G. taylori* in colour, photographed by R. Kuiter, at Seal Rocks, New South Wales at 2 m depth.

Acknowledgements

Thanks to Richard Taylor and Peter Schüpp, both formerly University of New South Wales, for collecting and photographing the holotype respectively, and thanks to Rudie Kuiter for information regarding his photograph of *G. taylori* from Seal Rocks. Comments from two anonymous reviewers are gratefully acknowledged. This study was supported by an Australian Postdoctoral Fellowship from the Australian Research Council to STA.

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Rediagnosis of *Palaemon* and differentiation of southern Australian species (Crustacea: Decapoda: Palaemonidae)

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Abstract

Walker, T.M., and Poore, G.C.B. 2003. Rediagnosis of *Palaemon* and differentiation of southern Australian species (Crustacea: Decapoda: Palaemonidae). *Memoirs of Museum Victoria* 60(2): 243–256.

Examination of the morphology of palaemonine shrimps from Tasmania and south-eastern Australia, and molecular analyses by other authors, necessitated an examination of the validity of some characters used for generic differentiation within the Palaemoninae and a redefinition of the genus *Palaemon*. A new species, *Palaemon dolospina* sp. nov., is described from Margate Beach in south-eastern Tasmania. *Palaemon intermedius* (Stimpson, 1860) is redescribed. Both species vary between localities across southern Australia. Keys are presented for the small estuarine and marine shrimps of Palaemoninae in southern and south-eastern Australia belonging to genera, *Palaemon* and *Palaemonetes*. One species of *Palaemon* has been introduced to Australia from overseas.

Key words Crustacea, Caridea, Palaemonidae, *Palaemon*, new species, Australia

Introduction

An investigation of Tasmanian palaemonids shrimps usually known as *Macrobrachium intermedium* from the North West Bay River Estuary and D'Entrecasteaux Channel in south-eastern Tasmania revealed not only the presence of two forms in these environments but also the presence of a similar new species in the estuary. Both species are common in seagrass and, in eastern and south-eastern Tasmania, occur sympatrically in the seagrasses *Zostera muelleri* and *Heterozostera tasmanica*. Further study showed that the first is widespread in marine and estuarine waters from Western Australia to Queensland. The new species has not been located outside South Australia, Tasmania and Victoria. It is generally found in estuarine waters or, in Tasmania, in shallow marine waters where the other is absent.

Neither species complies well morphologically with the generic diagnoses of *Macrobrachium* or the alternative, *Palaemon*. Analyses using allozymes and molecular information from 16S rRNA strongly suggested that *M. intermedium* was more closely related to *Palaemon serenus* (Heller, 1862) (Murphy and Austin, 2002) or to *Palaemonetes australis* Dakin, 1976 (Boulton and Knott, 1984; Murphy and Austin, 2003) than to other species of *Macrobrachium*. This paper re-examines morphological characters used in generic classification within the subfamily Palaemoninae and redefines *Palaemon*. Both species are described and assigned to *Palaemon*, henceforth *P. intermedius* (Stimpson, 1860) and *P. dolospina* sp. nov.

We follow Bruce (1992) in treating the gills of maxilliped 3 as two arthrobranchs (one rudimentary) rather than one pleurobranch, said by Holthuis (1993) and earlier workers to define the subfamily Palaemoninae.

Palaemon is separated from *Palaemonetes*, *Macrobrachium* and other palaemonine genera principally on the basis of the presence and form of the branchiostegal groove, the presence or absence of branchiostegal and hepatic spines, the form of the second pereopods and the presence or absence of a mandibular palp. Problems with the use of these characters were noted previously by Fujino and Miyake (1968), Chace (1972), Bray (1976) and Boulton and Knott (1984). We reviewed these characters in eight southern Australian species (Table 1).

Palaemon is said to be separated from *Macrobrachium* by the presence of a branchiostegal spine and smooth second pereopods while *Macrobrachium* has an hepatic spine and spinulose second pereopods in males of many species. In *Palaemon*, adult females are larger than males while males are usually larger in *Macrobrachium*.

Most species of *Macrobrachium* have an hepatic spine set well back from the carapace edge on or just below the ridge of the antennal spine (Fig. 1). The branchiostegal groove is short,

Table 1. Characters of some Australian species of *Palaemon*, *Palaemonetes* and *Macrobrachium*

	Palaemon intermedium	*Palaemon dolospina*	*Palaemon serenus*	*Palaemon debilis*	*Palaemonetes australis*	*Palaemonetes atrinubes*	*Macrobrachium novaehollandiae*	*Macrobrachium rosenbergii*
Carapace spine	open posteriorly; migrates from carapace edge in early post-larval stages	set back from (tip just reaching) carapace edge; migrates from carapace edge in early post-larval stages	set on carapace edge, just below start of branchiostegal groove	set on carapace edge, short distance below start of branchiostegal groove	set well back from (tip not reaching) carapace edge; migrates from carapace edge in early post-larval stages	set on carapace edge, just below start of branchiostegal groove	closed posteriorly; migrates from carapace edge in early post-larval stages	closed posteriorly; migrates from carapace edge in early post-larval stages
Branchiostegal groove	running up to spine and stopping at dorsoposterior edge	running up to spine, looping over it and sweeping down posteriorly	starting on top of spine, sweeping to posterior in shallow arc	starting above spine, sweeping to posterior in shallow arc	sweeping to posterior in shallow arc, may deviate slightly over spine	starting on top of spine, sweeping to posterior in shallow arc	running up to spine and stopping	running up to spine and stopping
Mandibular palp	present in adults, 3 articles (absent in first postlarva)	present in adults, 3 articles (absent in first postlarva)	present in adults, 3 articles	present in adults, 3 articles	usually absent, if present of 1 or 2 articles	absent	present in adults, 3 articles	present in adults, 3 articles (absent in first postlarva)
Pereopod 2 of adult	~equal, same in both sexes, smooth	~equal, same both sexes, smooth	~equal, same in both sexes, smooth	~equal, same in both sexes, smooth	~equal, same in both sexes, smooth	~equal, same in both sexes, smooth	?equal, larger in males, spinulose	?equal, larger in males, spinulose
Larger sex	Female	Female	Female	Female	Female	Female	Male	Male

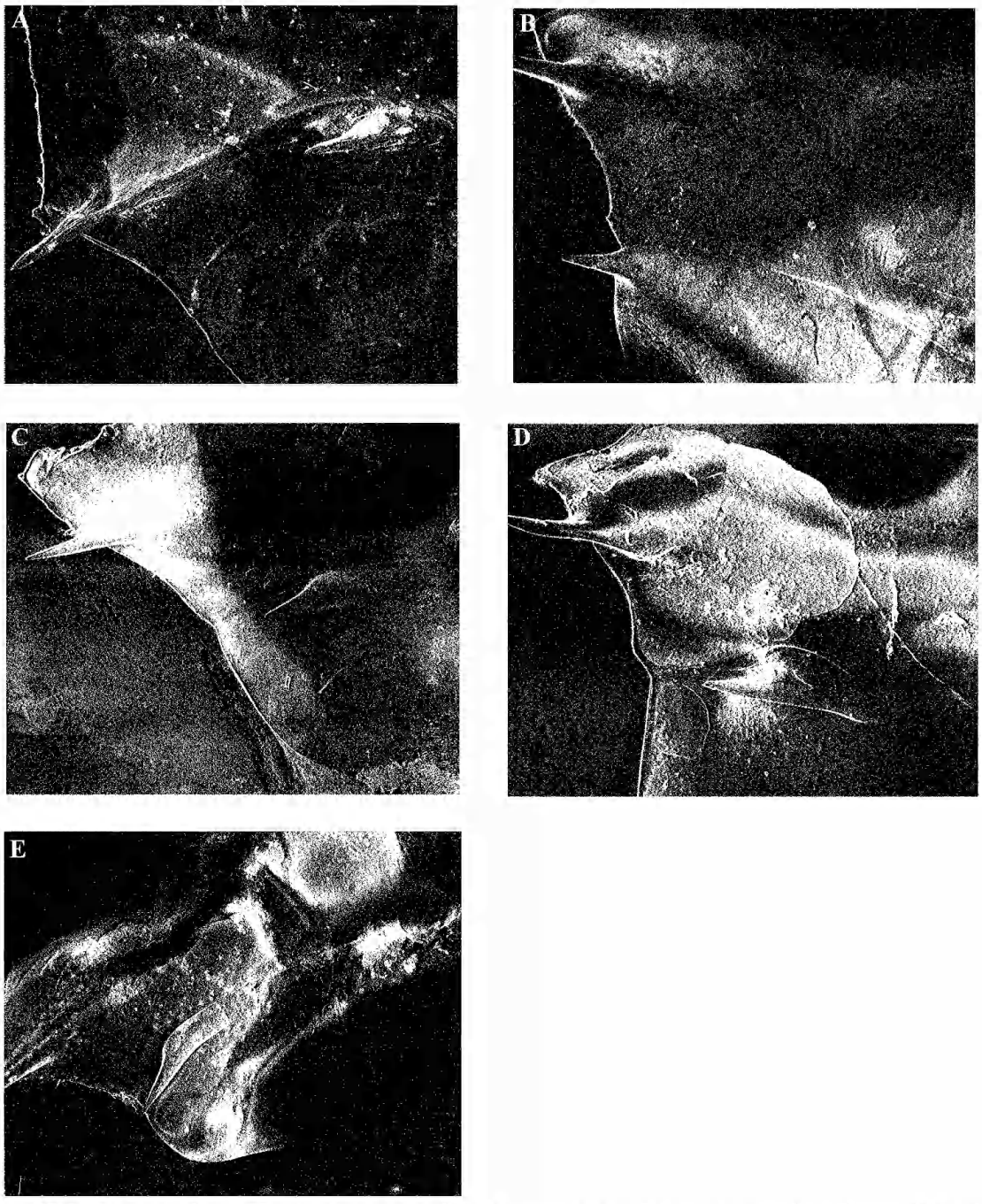

Figure 1. SEMs of carapace spines. a, *Macrobrachium rosenbergii*; b, *Palaemon serenus*; c, *Palaemonetes australis*; d, *Palaemon intermedius*; e, *Palaemon dolospina*.

and runs from the carapace edge to the front of the base of the spine and stops there. The back of the spine is closed with a suture line surrounding the spine where it makes contact with the carapace and it is usually flattened dorsoventrally. The hepatic spine is well removed from the anterior edge of the carapace (Holthuis, 1950) by a distance greater than its length.

In most species of *Palaemon* (and *Palaemonetes*) there is a branchiostegal groove running back from the anterior edge of the carapace in a shallow arc near the junction of the branchiostegite and the thorax (Fig. 1). Its length generally varies from a quarter to a half of the carapace length. A branchiostegal spine is found below this groove, usually on the carapace edge close to the start of the groove. However, the spine may be found removed ventrally from the groove somewhat and set back a little from the carapace edge. In Australian material, the spine is usually rounded rather than flattened and there is no distinct suture line where it is in contact with the carapace.

Within Australia, there is a continuum of spine/groove patterns between those typically found in *Palaemon* and *Macrobrachium*. *Palaemon serenus*, *Palaemon litoreus* (McCulloch, 1909), *Palaemon macrodactlyus* (Rathbun, 1902) and *Palaemonetes atrinubes* Bray, 1976 have a typical branchiostegal groove and the spine on the edge of the carapace (Fig. 1b). *Palaemonetes australis* has the branchiostegal spine set well back from and not overlapping the carapace edge, with the groove of the usual form passing over it (Fig. 1c). *Palaemon dolospina* has a unique arrangement where a circular spine is set back from the carapace edge, but with the tip just overlapping it in some individuals (Fig. 1e). The spine is displaced dorsally to an almost hepatic position. The branchiostegal groove runs back into the spine but is then displaced dorsally, loops over the spine and runs past it in a ventroposterior direction for a distance equal to about twice the length of the spine. As the spine is below the branchiostegal groove, it can considered to be branchiostegal.

Palaemon intermedius possesses what appears to be an hepatic spine, but it is not set as far back from the carapace edge as is usual in that genus, and is lower on the carapace, being nearer the junction of the branchiostegite and thorax (Fig. 1d). The groove runs into the front of the spine but the latter is open posteriorly, having no suture line where it meets the carapace at that point. The groove or suture line dorsal to the spine extends further posteriorly than that ventral to it and may represent a short extension of the branchiostegal groove over the spine. The spine is flattened dorsoventrally.

Macrobrachium rosenbergii (De Man, 1879) (Fig. 1a), *M. lar* (Fabricius, 1798) and other Australian species of this genus have a typical hepatic spine set high up on the carapace with the branchiostegal groove running up into it and stopping. The spine is surrounded by a suture line where it joins the carapace, and its tip is well removed from the anterior carapace edge.

The intermediate nature of the two species can be appreciated by examination of post-larvae and juveniles. Both species have no branchiostegal groove and a branchiostegal spine on the edge of the carapace (Fig. 2). Over a series of moults, the spine migrates away from the carapace edge to its final adult position as the branchiostegal groove forms. This was also found to occur in *Macrobrachium australe* (Guérin-Méneville, 1838), *M. latimanus* (Von Martens, 1868) and *M. lar* by Holthuis (1950). Other species are similar: *M. nipponense* (De Haan, 1849) (Kwon and Uno, 1969), *M. rosenbergii* (see Uno and Kwon, 1969), *M. australiense* Holthuis, 1950 (Fielder, 1970), *M. niloticum* (Roux, 1833) (Williamson, 1972), *M. novaehollandiae* (De Man, 1938) (Greenwood et al., 1976), *M. equidens* (Dana, 1852) (Ngoc-Ho, 1976) and *M. lar* (see Atkinson, 1977).

Thus it appears that the " hepatic" spine of *Macrobrachium* and "branchiostegal" spine of *Palaemon* and related genera are homologous. An "hepatic" spine appears to be a branchiostegal spine that has migrated during post-larval and juvenile development. The groove appears to be displaced upwards and remains developed only between the carapace edge and the spine. One exception is found in *M. palaemonoides* Holthuis, 1950, where the spine is in an hepatic position but the groove passes below the spine (Holthuis, 1950). A consequence of this realisation is that while adults of *Macrobrachium* and *Palaemon* can be assigned to to their respective genera on this character, juveniles cannot and other characters must be applied to distinguish juveniles.

This ontological process appears to be arrested in *Palaemon intermedius* and *P. dolospina* but other characters such as features of pereopod 2 place them clearly in *Palaemon*.

Palaemonetes differs from *Palaemon* solely by the absence of a mandibular palp. Incidentally, the same character differentiates *Pseudopalaemon* Sollaud, 1911 from *Macrobrachium*. Most specimens of the two Tasmanian species have a three-articled palp. Boulton and Knott (1984) noted difficulties identifying the joint between the second and third article in *Palaemon intermedius* from Swan River, WA. The palp is absent in the first post-larval stage and present as a small bump in the second post-larval stage, developing into its normal form over the next few moults (Fig. 4m). This developmental change is widespread in *Palaemon*, *Macrobrachium* and *Leptocarpus* (e.g. Ngoc-Ho, 1976).

The mandibular palp varies in adults of some species or in some populations of some species. Chace (1972) reported specimens of *Palaemon debilis* Dana, 1852 from Hawaii with between one and three articles or no mandibular palp at all. Fujino and Miyake (1968) found the same for five species of *Palaemon* from Japan, and the same discrepancy between two sides of a single individual. Among 20 specimens of *Palaemon* cf. *debilis* from Coila Lake, NSW, the number of palp articles ranged from none to two (65%). Bray (1976) found *Palaemonetes australis* Dakin, 1915 from WA with a mandibular palp of one or two articles or without a palp.

The doubtful status of *Palaemonetes* has been noted previously on grounds of morphology (Chace, 1972; Bray, 1976), morphology and allozymes (Boulton and Knott, 1984) and mitochondrial genes (Murphy and Austin, 2003). Placing it in synonymy with *Palaemon* may not be appropriate since the form of the mandibular palp is consistent once adult state is achieved in at least some Australian species, *Palaemonetes atrinubes* and the two described below. Nevertheless, it is

variable in *Palaemonetes australis* and *Palaemon* cf. *debilis*. A final decision on the synonymy would require a more thorough examination of species beyond Australia.

The second pereopods of most, though not all, species of *Macrobrachium* (and *Chryphiops* Dana, 1852) are larger and often spinulose in adult males.This is a useful character for the generic identification of sexually mature males, but it is of no use in juveniles or females which resemble members of other genera such as *Palaemon* and *Palaemonetes*.

Pending a major revision of the Palaemoninae, Australian species may be divided into three groups. The first includes all species of *Macrobrachium* sensu stricto, which occupy freshwater or estuarine habitats, have markedly sexually dimorphic second pereopods, larger males than females and the hepatic spine/groove arrangement typical of that genus. The second group is *Palaemon serenus*, *P. litoreus*, *P. macrodactylus* (introduced), *P. dolospina* and *P. intermedius*. These occupy marine and estuarine habitats, are robust, females are larger than males, the second pereopods are similar in both sexes, a proximal tuft of setae is present dorsally on the telson and they always possess a mandibular palp of three articles. The third group contains *Palaemonetes atrinubes*, *Palaemonetes australis*, *Palaemon debilis* and possibly another species close to *P. debilis*. These occupy marine and estuarine habitats, are less robust than those of the second group, have more slender pereopods, have larger females than males, the second pereopods are similar in both sexes, there is no proximal tuft of setae on the telson, and the number of articles in the mandibular palp appears to be variable with a tendency to be reduced or absent.

In spite of the shortcomings of the characters discussed above, it is possible to redefine *Palaemon* around the second and third groups of species and include the following two species.

Palaemon Weber, 1795

Palaemon Weber, 1795: 94.—Holthuis, 1950: 42–44 (extended diagnosis).—Holthuis, 1993: 112–114 (synonymy).

Diagnosis. Rostrum well developed, toothed dorsally and ventrally, without an elevated basal crest; upper margin bearing single row of setae between dorsal teeth. Carapace smooth, bearing distinct branchiostegal spine and groove; branchiostegal spine usually situated on carapace edge but may be set back; groove usually running straight back from carapace edge in a shallow arc but may rise upwards and over spine before continuing posteriorly or, in *P. intermedius*, into and over but not past its posterior edge. Antennal spine generally strong, on anterior margin of carapace some distance below rounded lower orbital angle. Mandibular palp usually of 2 or 3 articles, but may be absent. Eyes distinctly pigmented, cornea well developed. Anterior margin of antennular peduncle rounded, anterolateral spine small. First pleopod of male without or with rudimentary appendix interna on endopod. Propodus of fifth pereopod with several transverse rows of setae on distal part of the posterior margin. Telson with 2 slender median setae on posterior margin. Pleura of fifth abdominal somite usually ending in small sharp point.

Remarks. The revised diagnosis allows for the variable position of the branchiostegal spine and accommodates the hepatic position of this spine seen in some Australian species.

Palaemon intermedius (Stimpson)

Figures 1d, 2a–e, 3a, 3b, 4, 5

Leander intermedius Stimpson, 1860: 41.—Haswell, 1882: 195.—Whitelegge, 1889: 224 (record in Port Jackson).—Thomson, 1893: 51 (record in Tas.).—Stead, 1898: 210.—Sayce, 1902: 155 (record in Port Phillip Bay).—McCulloch, 1909: 309, pl. 89 figs 13, 14.—Hale, 1927a: 58–59, fig. 53 (record in SA).—Hale, 1927b: 309.—Anderson, 1938: 351 (record in Spencer Gulf).—Mack, 1941: 108 (diet of cormorants, Gippsland Lakes).—Thomson, 1946: 59, 67 (record in WA).—Holthuis, 1950: 20.

Palaemon (Leander) intermedius.—Miers, 1884: 295.

Macrobrachium intermedium.—Holthuis, 1952: 207–209 (redescription).—Poore et al., 1975: 35, 71 (distribution in Port Phillip Bay).—Walker, 1979 (redescription and ecology in Tas.).—Boulton and Knott, 1984: 769–784 (ecology in WA).—Davie, 2002: 296.

Material examined for redescription. 15 males, 12.7–27.3 mm body length , 20 females including 7 ovigerous, 12.7–34.5 mm body length, Margate Beach, mouth of North West Bay River Estuary, Tasmania, T. Walker, 1975. 4 adult females, D'Entrecasteaux Channel, Middleton, 14 m, Tasmania, T. Walker, Khin Khin U and T. Sward, 11 Apr 1975. 4 ovigerous females, 2 mature males, Western Port, Victoria, Fisheries and Wildlife Department, Victoria, 29 Nov 1973. 3 ovigerous females, 1 mature male, Spalding Cove, 4–12 m, South Australia, 5 Nov 1969.

Additional material. Numerous sites in Tasmania, Victoria, South Australia, Western Australia, New South Wales, Queensland; including many lots registered in Museum Victoria.

Diagnosis. Carapace smooth; branchiostegal spine set back from anterior edge of carapace and open posteriorly; branchiostegal groove running from carapace edge upwards and posteriorly to dorsoposterior edge of the spine where it stops. Rostrum upper border with 7–10 teeth (usually 8 or fewer, commonly 9); 2–3 of these (usually 2) postorbital; dorsal teeth evenly spaced although proximal 3 or 4 often closer together than remainder and incompletely articulated; ventral rostral border with 4–6 teeth (usually 5) evenly spaced over distal two-thirds;

Description. (*based on 15 males, 20 females from Margate Beach, Tasmania*) Maximum body length (orbit to telson tip) c. 30 mm in males, c. 40 mm in females.

Carapace smooth; antennal spine strong and marginal; branchiostegal spine set back from anterior edge of carapace and open posteriorly; branchiostegal margin rounded, branchiostegal groove running from carapace edge upwards and posteriorly to dorsoposterior edge of the spine where it stops.

Eyes well developed, with ocellus; interocular tooth well developed.

Rostral tip level with or exceeding terminal setae of scaphocerite; length:depth ratio 6.9–10.0 in males, 6.2–8.8 in females; upper border straight to concave; body length:rostral length ratio 2.5–3.1 in males, 2.8 – 3.6 in females; lateral carina gently and concavely curved, degree of curvature variable; third to half rostrum above lateral carina; upper border with 7–10 teeth (usually 8 or less commonly 9); 2–3 of these (usually 2) postorbital; dorsal teeth evenly spaced although

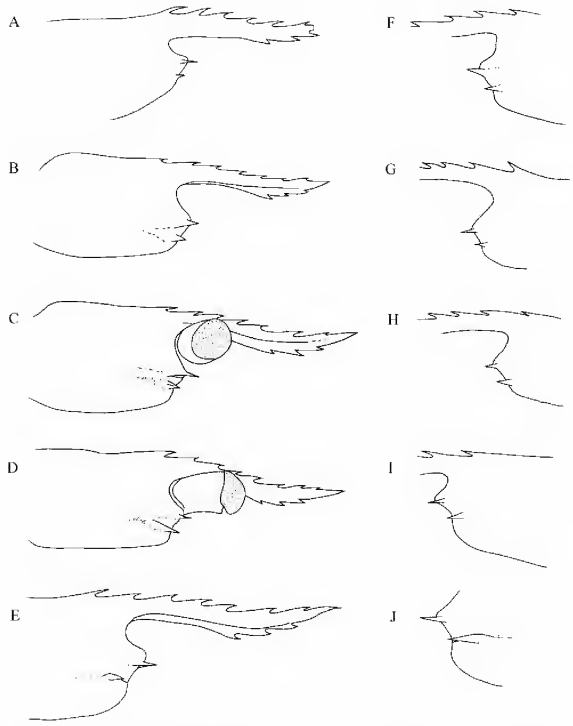

Figure 2. Migration of the carapace spine during growth to final position. a–e, *Palaemon intermedius*; f–j, *Palaemon dolospina*. Body lengths of shrimps (mm): a, 6.0; b, 6.2; c, 6.5; d, 6.6; e, 6.6; f, 6.3; g, 6.2; h, 6.3; i, 6.8; j, 8.4.

proximal 3 or 4 are often closer together than remainder and incompletely articulated; rostral tip usually bifid but may be trifid or a single point; single row of plumose setae along upper border between but not on teeth; ventral rostral border with 4–6 teeth (usually 5) evenly spaced over distal two-thirds; 2 rows of plumose setae on ventral border between but not on teeth.

Antennule well developed, article 1 of peduncle about 2.5 times length of articles 2 and 3; article 2 slightly longer than 3, bearing elongate, blunt projection on medial edge; basal article elongate and rectangular, about 2.3 times as long as wide, expanded and flattened on its inner edge, bearing several transverse and longitudinal rows of plumose setae, including subapical row extending across dorsal surface; setae longer over inner half of this row; basolateral spine slender, sharply pointed, reaching over half article 1; outer flagellum of antennular exopod much longer than inner flagellum; inner flagellum fused with outer usually over basal third of its length, about 13 articles in adult, fused up to half its length in juvenile; each free article of inner flagellum with medial and terminal transverse row of sensory setae, medial row bearing 3-4 setae and transverse row 4 setae in males, both rows bearing 3 setae in females.

Antenna with well developed peduncle with strong distolateral tooth, well developed flagellum and scaphocerite; proximal article of flagellum with blunt anteroventral projection; flagellum naked. Scaphocerite elongate, rectangular, extending well beyond peduncle, widest just anterior to its base, about one quarter of body length, 3.3–4.3 times as long as wide; distal and inner lateral edges bearing row of long plumose setae; outer edge naked, slightly concave, ending distally in well developed tooth that just fails to overlap anterior edge of lamella; inside edge straight or slightly concave.

Mandible- incisor of one side with 3 teeth (either side), incisor of the other usually with 4; palp with 3 articles; article 3 longest, with 3 terminal setae longer than article.

Maxillule endopod with bifid tip; distal lobe acute, naked; proximal lobe bearing 1 plumose seta; coxal endite with long setae and terminally 4–5 stout setae; basal endite with 3 rows of stout setae along terminal, inner edge extending down proximal margin as longer setae.

Maxilla basal endites elongate, nearly rectangular, both bearing long, stout setae terminally, distal endite with row of 5 setae along distal margin near its base; endopod with 3 short setae; scaphognathite proximal lobe wider and shorter than distal; coxa with small expansion near base (?epipod).

Maxilliped 1 with rectangular coxa with endite and bilobed epipod; basis with endite; endopod with 1 long, subterminal seta; well developed exopod with prominent lateral lobe; endites with stout setae along mesial edges, and distal on basal endite; both with single row of similar setae on posterior face.

Maxilliped 2 with well developed exopod; coxa with poorly developed endite (on its outer edge), epipod and podobranch; ischiobasis about twice as long as wide, with scattered setae; endopod merus half length of ischiobasis, carpus about half length of merus, propodus expanded, about as long as merus but twice as wide, dactylus short and wide; anterior and mesial margin of propodus bearing rows of setae, some on anterior margin strong.

Maxilliped 3 epipod, medial margin setose; exopod extending beyond article 1 of endopod. Endopod ischio-merus 1.4–2 times as long as propodo-dactylus; carpus 1.2–1.6 times as long as latter; ischio-merus with 2 rows of long setae, one on each of posterior and anteromesial margins; carpus with similar rows and additional row on lateral surface; propodo-dactylus with stout terminal seta and numerous plumose and serrate setae, parallel rows of shorter, serrate setae across anteromesial surface and longer plumose setae elsewhere. Two arthrobranchs, one rudimentary and obscured by the larger; maxilliped endopod relatively shorter in males than females. Body length: maxilliped 3 length ratio 3.7– 4.5 in males, 3.5–4.3 in females.

Pereopod 1 articles smooth; reaching approximately to level of scaphocerite spine; tufts of serrate setae on posteroproximal region of palm and distomesial surface of carpus; outer surface of propodal finger with tufts of serrate setae, simple setae on both fingers; posteromesial ridge of ischium and merus with single row of long setae; fingers with simple cutting edge, 0.8–1.2 times as long as palm; carpus 1.5–2.5 times as long as chela and 1.1–1.4 times as long as merus; merus 1.1–1.9 times as long as ischium. Body length:pereopod 1 ratio 2.5–3.1 in males, 2.0–2.6 in females.

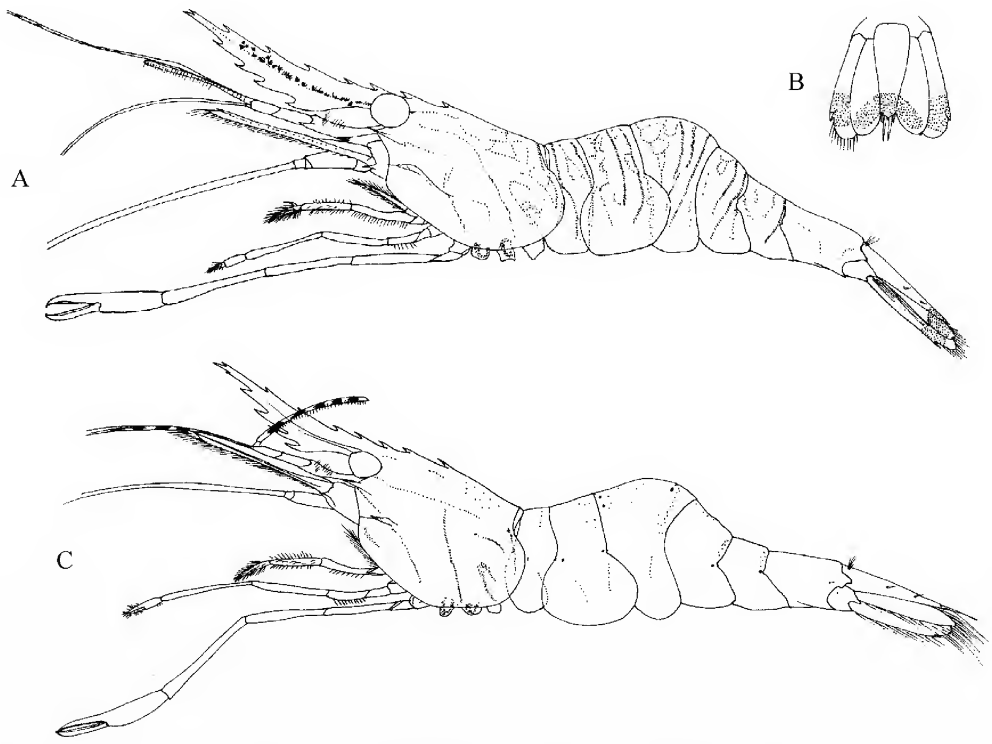

Figure 3. Habitus with colour pattern. a, *Palaemon dolospina*; b, telson of *P. dolospina*; c, *Palaemon intermedius*.

Pereopods 2 equal, similar in males and females, articles smooth, usually exceeding scaphocerite by all of palm; fingers slender, curved, with small tooth at base, cutting edges serrate, sometimes one or both smooth, particularly in smaller individuals; palm swollen, laterally flattened, 2.8–3.4 times as long as wide; palm 0.9–1.2 as long as fingers, usually longer; carpus long and slender, narrow proximally, 6.0–8.5 times as long as wide at that point, distally 1.7–2.4 times as wide as at base, length 6.0–8.5 times distal width; chela 0.9–1.4 times as long as carpus and 1.2–1.5 times merus; merus 1.0–1.3 times as long as ischium. Body length:pereopod 2 ratio 1.6–1.9 in males, 1.3–1.8 in females.

Pereopods 3–5 progressively longer, mainly owing to increase in lengths of propodi.

Pereopod 3 simple, slightly less than half body length; dactylus with small cutting edge on posterior border; propodus with 2 rows of long setae anteriorly, 2 variable rows of short plumose setae, outer row with 5–9 setae; propodus 2.0–2.5 times as long as dactylus and 1.5–1.9 times as long as carpus in males, 1.6–2.4 in females; merus 1.1–1.3 times as long as propodus and 1.1–1.5 times as wide; merus 1.9–2.4 times as long as ischium; 1.9–2.1 times as long as carpus in males, 1.9–2.4 in females.

Pereopod 4 similar to 3, but slightly longer; propodus length about 2.5 times as long as dactylus, about twice as long as carpus; merus about same length as propodus and twice as long as ischium.

Pereopod 5 similar to 3 and 4, slightly longer than 4; row of 5–7 short setae on lateral posterior margin of propodus with 5–7 parallel rows of serrate setae distally; mesial posterior edge with row of 7–10 short setae. Propodus 2.6–3.1 times as long as dactylus in male, 2.0–2.8 in female.

Branchial formula (r = rudimentary).

	Maxillipeds			Pereopods					Total gills
	1	2	3	1	2	3	4	5	
Pleurobranchs	–	–	–	1	1	1	1	1	5
Arthrobranchs	–	–	1+1r	–	–	–	–	–	1 + 1r
Podobranchs	–	1	–	–	–	–	–	–	1
Exopods	1	1	1	–	–	–	–	–	3
Epipods	1	1	1	–	–	–	–	–	3

Pleopod 1 with well developed exopod and smaller endopod; appendix interna absent. Endopod of male little more than half as long as exopod, with convex outer edge, concave inner edge, about 4 times as long as wide. Endopod of female smaller, about one third as long as exopod, about 3 times as long as wide.

Pleopods 2–5 with equally developed exopod and endopod; endopod with appendix interna. Endopod of male pleopod 2 with appendix masculina, longer than appendix interna, usually with 22 setae along its length, 6 of which are apical or subapical; each seta up to half as long as appendix masculina.

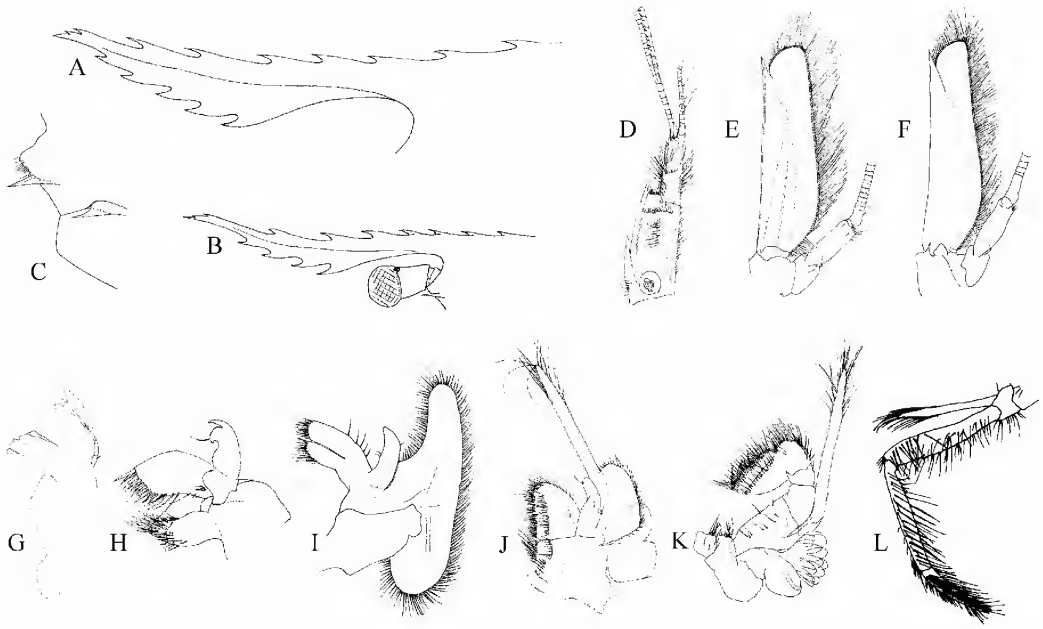

Figure 4. *Palaemon intermedius*. a, rostrum (female, 33.2 mm); b, rostrum (male, 20.8 mm); c, carapace spine (female, 30.2 mm); d, e, antennule and scaphocerite (female, 30.2 mm); f, scaphocerite (male, 28.0 mm); g, mandible; h, maxillule; i, maxilla; j–l, maxillipeds 1–3; m, mandible of post-larva (all mouthparts, female, 30.2 mm).

Pleopods 1–2 and to a lesser extent 3–5 with keel-shaped, flattened extension on lateral edge, smaller in male than female.

First abdominal pleuron about 2–3 times as long as wide; second abdominal pleuron about 1.5 times as long as wide; apex of fifth pleuron acute, with short terminal spine; sixth abdominal article 1.4–1.8 times as long as fifth. Ventral edges of abdominal pleura with row of short, plumose setae.

Telson 2.0–2.5 times wider at base than apex, length 2.9–4.2 times basal width; 1.1–1.4 times as long as sixth abdominal somite; with 2 pairs of dorsal stout setae and larger inner and smaller outer terminal pair; apex produced into acute spine flanked by a 1 simple seta on each side and occasionally a shorter second pair; apical spine much shorter than the terminal setae; tuft of long plumose setae dorsomedially near base of telson.

Uropods endopod elongate, fringed with long plumose setae; exopod rectangular; transverse suture on exopod about two-thirds of distance from base; outer edge of exopod entire, ending at suture line in an immovable spine; second movable seta often present inside spine; remainder of margin fringed by row of long plumose setae; posterior to immovable spine, dorsally and ventrally, a row of about 12 long, non-plumose setae set back from margin, extending almost to apex of exopod; ventrally, outer margin from base of the exopod to the immovable spine with row of stout, simple setae just inside the margin.

Colour pattern. Carapace chromatophore lines usually red; abdominal markings generally olive green, black and red; accessory flagellum distinctly marked with alternate red and white bands.

Sexual dimorphism in adults. Males are smaller than females; with larger sternal process on the eighth thoracomere; smaller keel-like expansion on outer edge of peduncles of pleopods; appendix masculina on pleopod 2; significantly larger endopod on pleopod 1; 4 setae in distal sensory row on each article of antennular inner flagellum (3 in adult female); rostrum more slender and longer; longer carpus in pereopod 2; maxilliped 3, pereopods 1 and 3 shorter relative to body length; the ratio of length of propodus and dactylus of pereopod 5 significantly greater.

Females ovigerous from 19.5 mm body length; bearing approximately 100–700 ovoid eggs, larger females bearing more eggs; egg size 0.55–1.0 mm depending on developmental stage, 0.9–1.0 mm when ready to hatch.

Ontogenetic changes. Some characters alter as the size of males and females increases. In females, the scaphocerite becomes stouter and shorter relative to body length; the number of articles over which the antennular flagella are fused increases; the carpus and merus of pereopod 1 become longer relative to other articles; the number of parallel rows of setae on the propodus of pereopod 5 increases, and pereopod 2 becomes longer. In males, the number of articles over which the antennular flagella are fused increases; length ratios between articles of pereopods 1–5 differ; pereopod 1 becomes slightly shorter relative to body length.

In early post-larval stages, the mandibular palp and the branchiostegal groove are absent and a branchiostegal spine is present on the edge of the carapace. Over a series of moults, a palp of three articles and the branchiostegal groove form and

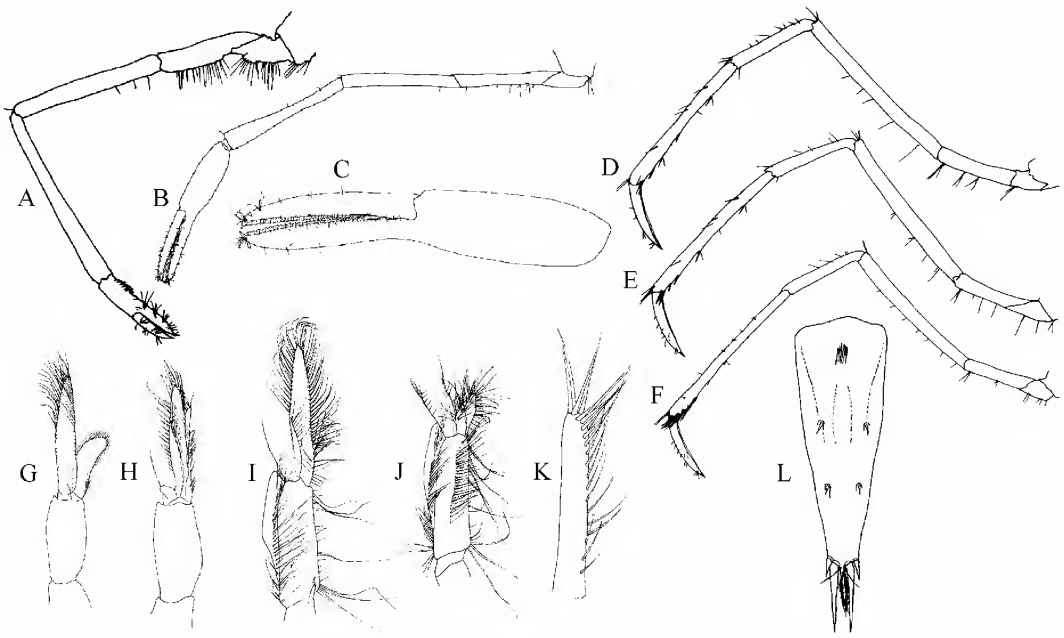

Figure 5. *Palaemon intermedius*. a–f, pereopods 1–5; b details of chela of pereopod 1 (male, 28.0 mm). g, h, pleopods 1, 2 (male); i, j, pleopods 1, 2 (female). k, telson. l, appendix masculina.

the branchiostegal spine migrates posteriorly and upwards to its final position in adults.

Variation. The type or types of *Leander intermedius* Stimpson, 1860 are lost. They were collected from Port Jackson, NSW. Examples of the species from nearby Port Hacking most resemble the typical Tasmanian form from Margate Beach but examples from other locations including Tasmania differ.

Deep-water form (5 adult females, 29.3–36.6 mm, D'Entrecasteaux Channel). More slender and longer legged than shallow water form. Scaphocerite more slender, rostrum with 2–3 but usually 3 postorbital teeth rather than 2; Pereopods 1, 3, 5 longer, body length 2.2–2.3 times as long as pereopod 1, 1.7–1.9 times as long as pereopod 2, 1.5–1.6 times as long as pereopod 5; carpus of pereopod 2 longer, carpus length 2.0–2.3, 3.7–4.7, 1.2–1.4 and 1.9–2.1 times as long as chela, fingers, merus and ischium respectively; palm more swollen, length 2.6–2.8 times its maximum width; apex of carpus more expanded; pereopods 3 and 5 with longer propodus; telson stouter, at least at its base, 2.2–3.8 times as long as basal width.

Intermediate form (4 ovigerous females, 21.2–33.0 mm, 2 adult males 26.2 mm, Western Port, Vic.). More similar to the deep-water form particularly in number of postorbital rostral teeth, length of pereopods 2, 3, 5, and the degree the palm is swollen on pereopod 2.

South Australian form (3 females (2 ovigerous) 21.9–35.9 mm, 1 adult male 20.8 mm, Spalding Cove, Port Lincoln. SA). Resembles closely Tasmanian material except for 3 postorbital rostral teeth and a more swollen palm on pereopod 2.

Remarks. Palaemon intermedius bears what appears to be an hepatic spine but it is set lower down and not as far back from the carapace edge as is usual in *Macrobrachium*, the genus to which it was assigned by Holthuis (1952). The branchiostegal groove appears to run back to the spine and over it, but ceasing at the back of the spine. The spine is open posteriorly, having no suture line between it and the carapace in that region. The migration of the branchiostegal spine from the carapace edge during ontogeny is arrested partly completed and the value of this character for generic assignment is therefore limited. Generic assignment is based principally on the other characters.

Palaemon dolospina sp. nov.

Figures 1e, 2f–j, 3c, 6, 7

Palaemon sp.—Walker, 1979.

Material examined. Holotype. Margate Beach, North West Bay, Tas. (lat long) in *Zostera muelleri* and *Heterozostera tasmanica* on sand, 0.2–1 m, T. Walker, 12 Dec 1973, NMV J52659 (male, 6.5 mm postorbital carapace length, 42 mm total length).

Allotype. Collected with holotype, NMV J52660 (ovigerous female, 8.9 mm postorbital carapace length, 45 mm total length)

Paratypes. Collected with holotype, NMV J52661 (92 specimens, 4.7–9.0 mm postorbital carapace length)

Material described. 26 males, 12–35 mm body length, 28 females, including 6 ovigerous, 12.6–40 mm body length, Margate Beach and in brackish water from North West Bay River Estuary, Margate, Tasmania, in seagrasses *Zostera muelleri* and *Heterozostera tasmanica*, T. M. Walker, 1975. 1 ovigerous female, 32.1 mm body length, Western Port, Victoria, intertidally on mud, Fisheries and Wildlife

Figure 6. *Palaemon dolospina.* a, rostrum (female, 31.8 mm); b, rostrum (male, 32.8 mm); c, carapace spine (female, 31.8 mm); d, e, antennule and scaphocerite (female, 31.8 mm); f, scaphocerite (male, 31.8 mm); g, mandible; h, maxillule; i, maxilla; j–l, maxillipeds 1–3 (all mouthparts, female, 31.8 mm).

Department, Victoria, 8 Jan 1974. 8 females, 2 ovigerous 13.9–34.6 mm, 6 males, 15.3–23.8 mm, ICI Saltfields, Port Gawler, South Australia, ICI staff ,13 Jan 1973. 6 ovigerous females, 37.7–50.7 mm, Newport Power Station, Victoria. H.A. Morrison, 21 July 1949.

Additional material from 50 sites in Tasmania (including Flinders and King Islands), 2 in Victoria, 3 in South Australia.

Diagnosis. Carapace smooth; branchiostegal spine set back from and its tip barely reaching anterior carapace edge, set high up on brachiostegite; branchiostegal groove runs up to, loops over the spine and sweeps down again posteriorly. Rostrum upper border with 6–9 teeth; 1–2 of these (usually 2) postorbital; dorsal teeth unevenly spaced, first set back from rest on carapace, next 3 or 4 evenly spaced, incompletely articulated, increasingly longer gap between next 3 until penultimate tooth close to distal tooth; ventral rostral border with 3–6 teeth (usually 4), evenly spaced over distal two-thirds.

Description. (based on 26 males, 28 females from Margate Beach, Tasmania. Characters resembling P. intermedius *not described)* Maximum body length (orbit to telson tip) c. 42 mm in males, c. 51 mm in females.

Carapace smooth; antennal spine strong and marginal; branchiostegal spine set back from and its tip barely reaching anterior carapace edge, set high up on brachiostegite; branchiostegal groove runs up to, loops over the spine and sweeps down again posteriorly.

Eyes well developed, with ocellus; interocular tooth well developed.

Rostral tip exceeding lamella of scaphocerite; length:depth ratio 6.5–9.3 in males, 5.3–7.6 in females; upper border straight to concave; body length:rostral length ratio 2.4–3.6 in males, 2.5–3.5 in females; lateral carina gently concave and directed upwards at tip; third to half rostrum above lateral carina; upper border with 6–9 teeth; 1–2 of these (usually 2) postorbital; dorsal teeth unevenly spaced, first set back from rest on carapace, next 3 or 4 evenly spaced, incompletely articulated, increasingly longer gap between next 3 until penultimate tooth close to distal tooth; rostral tip appears bifid; single row of plumose setae along upper border between but not on teeth; ventral rostral border with 3–6 teeth (usually 4), evenly spaced over distal two-thirds; 2 rows of plumose setae on ventral border between but not on teeth.

Antennule well developed; basal article bearing subapical transverse row of 10 plumose setae, not extending onto stylocerite; basilateral spine moderately slender, sharply pointed, reaching over half basal article of peduncle; inner flagellum fused with outer usually over basal third of its length, about 11–12 articles in male and 14–15 in female, fused up to half its length in juveniles; each free article of inner flagellum with mesial and terminal transverse row of sensory setae, mesial row of 3–4 and distal of 4 setae in female, mesial row of 4 and distal of 5 (occasionally 4) setae in male; sensory setae noticeably shorter than those in *P. intermedius*.

Antennal scaphocerite elongate, rectangular, widest near base, 3.2–4.1 times as long as wide; outer edge slightly convex to slightly concave, with terminal spine that just fails reach anterior edge of lamella; inside edge straight or concave over distal two thirds, convex proximally.

Mandible incisor of one side with 3 teeth (either side), incisor of the other usually with 4; palp with 3 articles; article

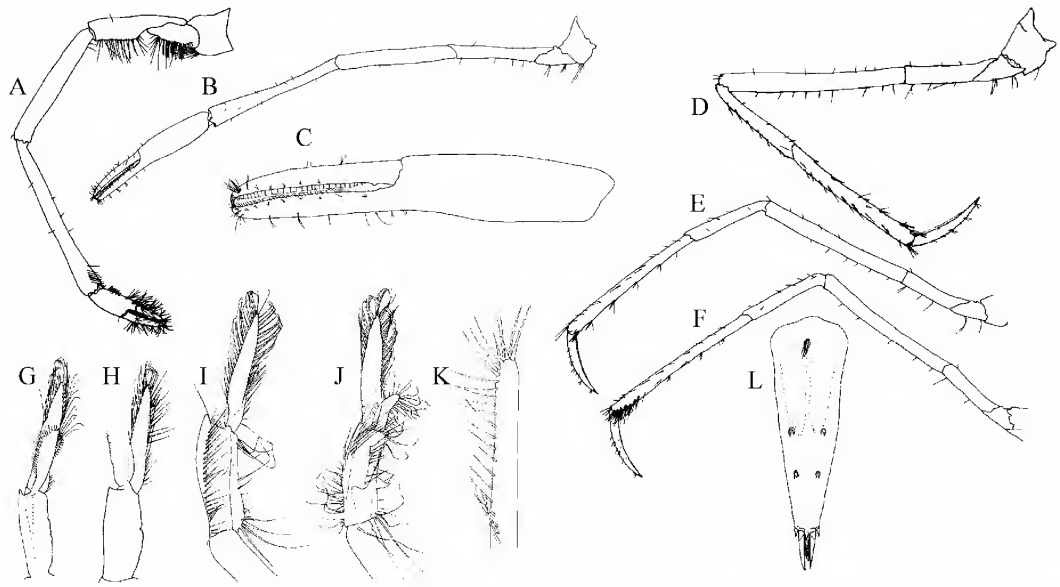

Figure 7. *Palaemon dolospina*. a–f, pereopods 1–5; b details of chela of pereopod 1 (male, 32.8 mm). g, h, pleopods 1, 2 (male); i, j, pleopods 1, 2 (female). k, telson. l, appendix masculina.

2 with 10 or more setae; article 3 slightly swollen, setose including 3 terminal and 2 subterminal setae; article 3 length about twice article 2, article 1 about 1.5 times article 2. Maxillule endopod with bifid tip, naked, distal lobe acute. Maxilla endopod with 2 short setae on inner edge and about 10 on proximal half of outer edge. Maxilliped 1 endopod without seta.

Maxilliped 3 epipod, mesial margin setose; exopod extending to end of article 1 of endopod. Endopod ischio-merus 1.3–2 times as long as propodo-dactylus; carpus 1.2–1.6 times as long as latter; ischio-merus with 2 rows of long setae, one on each of posterior and anteromesial margins; propodo-dactylus with stout terminal seta Body length:maxilliped 3 length ratio 3.8–4.5 in both sexes.

Pereopod 1 articles smooth; reaching approximately to tip of scaphocerite lamella; tufts of serrate setae on posteroproximal region of palm and distomesial surface of carpus; outer surface of propodal finger with tufts of serrate setae, simple setae on both fingers; posteromesial ridge of ischium and merus with single row of long setae; fingers with simple cutting edge, 0.8–1.4 times as long as palm; carpus 1.3–2.2 times as long as chela and 1.0–1.4 times as long as merus; merus 1.3–1.8 times as long as ischium. Body length:pereopod 1 ratio 2.4–2.9 in both sexes.

Pereopods 2 equal, similar in males and females, articles smooth, usually exceeding scaphocerite by at least fingers; fingers slender, curved, with small tooth at base, cutting edges serrate, sometimes one or both smooth, particularly in smaller animals; palm slightly swollen, laterally flattened, 2.6–4.0 times as long as wide; palm 1.0–1.4 as long as fingers; carpus long and slender, narrow proximally, thickens distally to be 1.5–2.5 times wider than at base, length:apical width ratio 6.4–8.8 in males, 5.2–7.7 in females; chela 0.8–1.2 times as long as carpus and 1.0–1.4 times merus; merus 1.0–1.5 times as long as ischium. Body length:pereopod 2 ratio 1.6–2.2 in both sexes.

Pereopods 3–5 progressively longer, mainly due to increase in lengths of propodi. Pereopod 3 reaching about end of scaphocerite; dactylus with small cutting edge on posterior border; propodus with 2 rows of long setae anteriorly, 2 variable rows of short flagellate setae, outer row usually with 4–5 setae in male, 5–6 in female, inner row usually with 3–5 in male, 5 in female; propodus 1.5–2.1 times as long as dactylus and 1.4–1.8 times as long as carpus in males, 1.6–2.0 in females; merus 1.0–1.4 times as long as propodus and 0.9–1.5 times as wide; merus 1.8–2.4 times as long as ischium; 1.6–2.2 times as long as carpus in male, 1.8–2.4 in female.

Pereopod 4 similar to 3, but slightly longer. Pereopod 5 similar to 3 and 4, slightly longer than 4.

Branchial formula as for *P. intermedius*.

Pleopod 1 with well developed exopod and smaller endopod; appendix interna absent. Endopod of male little more than half as long as exopod, with convex outer edge, concave inner edge, about 4 times as long as wide. Endopod of female smaller, about one third as long as exopod, about 3 times as long as wide.

Pleopods 2–5 with equally developed exopod and endopod; endopod with appendix interna. Endopod of male pleopod 2 with appendix masculina, longer than appendix interna, usually with 24 setae along its length, 6 of which are apical or subapical; each seta less than third as long as appendix masculina. Pleopods 1–2 and to a lesser extent 3–5 with keel-shaped, flattened extension on lateral edge, smaller in male than female.

First abdominal pleuron about 2–3 times as long as wide; second abdominal pleuron about 1.5 times as long as wide; apex of fifth pleuron acute, with short terminal spine; sixth abdominal article 1.3–1.9 times as long as fifth. Ventral edges of abdominal pleura with row of short, plumose setae.

Telson 2.0–2.8 times wider at base than apex, length 3.0–4.3 times basal width; 1.0–1.3 times as long as sixth abdominal somite; with 2 pairs of dorsal stout setae and larger inner and smaller outer terminal pair; apex produced into acute spine flanked by 1 simple seta on each side and occasionally a shorter second pair; apical spine much shorter than terminal setae; tuft of long plumose setae dorsomedially near base of telson.

Uropods endopod elongate, fringed with long plumose setae; exopod rectangular; transverse suture on exopod incomplete laterally, about two-thirds of distance from base; outer edge of exopod entire, ending at suture line in an immovable spine; second movable seta often present inside spine; remainder of margin fringed by row of long plumose setae; posterior to immovable spine, dorsally and ventrally, a row of about 9 long, non-plumose setae set back from margin, extending almost to apex of exopod; ventrally, outer margin from base of the exopod three quarters of the way to the immovable spine with row of stout, simple setae just inside the margin.

Colour pattern. Carapace chromatophore lines red; distinct transverse abdominal bars generally red but may be olive green; abdominal bars present on first post-larva as single lines of orange or yellow chromatophores; lateral carina of rostrum often with row of large, white chromatophores; hexagonal matrix of abdominal segments most distinct in large females, made up of small, olive green and some scattered white chromatophores; viewed dorsally, tail fan with white, transverse bands or patches.

Sexual dimorphism in adults. Males are smaller and more slender than females; with larger sternal process on the eighth thoracomere (almost absent in female); smaller keel-like expansion on outer edge of peduncles of pleopods; appendix masculina on pleopod 2; significantly larger endopod on pleopod 1; 5 setae in distal sensory row on each article of antennular inner flagellum (3–4 in adult female); rostrum more slender and longer; broader carpus in pereopod 2; longer carpus in pereopod 3; ratio of length of propodus and dactylus of pereopod 5 greater.

Females ovigerous from 25 mm body length; bearing approximately 140-840 ovoid eggs, larger females bearing more eggs; egg size 0.65-1.15 mm depending on developmental stage, 0.9–1.15 mm when ready to hatch.

Ontogenetic changes. Some characters alter as the size of recognisably male and female animals increases. In females, the rostrum and scaphocerite becomes stouter and shorter relative to body length; the number of articles over which the antennular flagella are fused increases; pereopods 2, 3, 5 become longer relative to the body; the fingers of pereopod 1 become shorter relative to other articles; the palm of pereopod 2 becomes less swollen, the carpus more expanded and fingers shorter; the number of parallel rows of setae on the propodus of pereopod 5 increases; and the telson becomes stouter. In males, the number of articles over which the antennular flagella are fused increases; length ratios between articles of pereopods 1–5 differ; carpus of pereopod 1 becomes relatively longer; pereopod 2 palm becomes less swollen and fingers shorter.

In early post-larval stages, the mandibular palp and branchiostegal groove are absent and a branchiostegal spine is present on the edge of the carapace. Over a series of moults, a palp of 3 articles and branchiostegal groove form and the branchiostegal spine migrates posteriorly and upwards to its final position in adults.

Etymology. From Latin, *dolus* meaning deceit and *spina*, a spine, alluding to the deceptive position of the branchiostegal spine.

Remarks. Palaemon dolospina bears a branchiostegal groove looping over a spine set back from the carapace edge albeit displaced dorsally somewhat. Consequently, although the spine is situated unusually high on the carapace between the usual branchiostegal and hepatic position, it can be defined as branchiostegal. Females are larger than males and the second pereopods of males are not spinulose or markedly sexually dimorphic. The mandibular palp is of three articles. In spite its unusual branchiostegal spine/groove arrangement, this species clearly belongs to *Palaemon*.

Keys to species of *Palaemon* and *Palaemonetes* from southern Australia

The shallow marine and estuarine Australian palaemonid fauna includes eight, possibly nine, species distributed as follows:

Palaemon debilis Dana, 1852 – Widespread in Indo-West Pacific, Qld, redescribed by Holthuis (1950) and Chace (1972).

Palaemon cf. *debilis* Dana, 1852 – NSW, eastern Vic., also similar to *Palaemonetes atrinubes* but its status remains unresolved.

Palaemon dolospina sp. nov. – Vic., Tas., SA.

Palaemon intermedius (Stimpson, 1860) – Qld (N to Moreton Bay), NSW, Vic., Tas., SA, WA.

Palaemon litoreus (McCulloch, 1909) – NSW, Vic., SA, WA. *Palaemon serenus* and *P. litoreus* have in the past, been separated on the basis of the carpus exceeding the palm of pereopod 2 in *P. serenus* but being shorter in *P. litoreus* (McCulloch, 1909; Hale, 1927b; Bray, 1976). Examination of material of both species from Western Australia has shown that, the carpus exceeds the palm in both species.

Palaemon macrodactylus Rathbun, 1902 – NSW, SA [native to Japan, Korea, northern China, introduced to San Francisco Bay and two Australian localities (Buckworth, 1979; Walker, 1979). Identifications of Australian material confirmed by TW and L. Holthuis, 1976].

Palaemon serenus (Heller, 1862) – southern Qld, NSW, Vic., Tas., SA WA.

Palaemonetes australis Dakin, 1915 – WA.

Palaemonetes atrinubes Bray, 1976 – NT, Qld, Vic, WA

1. Carapace spine set back from carapace edge by less than its length and situated between branchiostegite and ridge of antennal spine; open posteriorly; branchiostegal groove runs up to dorsoposterior edge of spine but not past it (Figs

1d, 4c); pereopod 2 smooth and equal; rostrum with 7–10 dorsal teeth, usually 8, 2–3 postorbital, proximal 4 incompletely articulated; 4–6, usually 5, ventral teeth ..... *Palaemon intermedius*

— Carapace spine set below branchiostegal groove which may deviate up and over the spine; spine may be on or set back from edge of carapace; pereopod 2 and rostrum not as above 2

2. Branchiostegal spine set back from the carapace edge, overlapping it at most only with tip 3

— Branchiostegal spine at or very near carapace edge just under start of branchiostegal groove; groove running back from carapace edge in a shallow arc, not upwards sharply and down again 4

3. Branchiostegal spine almost or just reaching carapace edge with tip only; set above level of starting point of branchiostegal groove which runs upwards to front of spine, loops sharply over it and sweeps down again posteriorly (Figs 1e, 6c); pereopod 2 carpus 1–1.5 times as long as merus; mandibular palp with 3 articles ..... *Palaemon dolospina*

— Branchiostegal spine set well back from the carapace edge which it never overlaps; branchiostegal groove deviating only slightly as it passes over spine (Fig 1c); pereopod 2 carpus 1.3–1.5 times as long as merus; mandibular palp absent ..... *Palaemonetes australis*

4. Antennule inner flagellum fused for greater than half of its length, usually over about two thirds, 16–20 articles fused in adults; mandibular palp absent ..... *Palaemonetes atrinubes*

— Antennule inner flagellum fused for half or usually less of its length, less than 15 articles fused in adults 5

5. Pereopods slender (carpus of pereopod 2 1.5–2.0 times as long as chela, 1.4–1.7 times as long as merus) 6

— Pereopods not unusually slender (carpus of pereopod 2 shorter than chela, 0.9–1.1 times as long as merus 7

6. Rostrum exceeding scaphocerite by at least quarter of its length; proximal 2 dorsal teeth fully articulated; 5–7 ventral teeth ..... *Palaemon debilis*

— Rostrum exceeding scaphocerite by less than quarter of its length; no fully articulated dorsal teeth; 3–4 ventral teeth ..... *Palaemon* cf. *debilis*

7. Pereopod 2 stout but short, 0.4–0.5 times body length ..... *Palaemon litoreus*

— Pereopod 2 stout but long, 0.7–0.9 times body length . .8

8. Rostrum with 9–15 dorsal teeth (usually 10–12), all incompletely articulated; teeth directed upwards; only one sixth of the antennule inner flagellum fused (4–6 articles) ..... *Palaemon macrodactlyus*

— Rostrum with 6–9 dorsal teeth, proximal 3 incompletely articulated; about one third of antennule inner flagellum fused (about 12 articles in adults) .... *Palaemon serenus*

In fresh material, pigmentation pattern can help separate species in this alternative key. The colour description for *Palaemon litoreus* was taken from a description by McNeill in Holthuis (1952) and those for *Palaemonetes australis* and *P. atrinubes* from Bray (1976).

1. Without dorsal hump on abdominal somite 3 2

— Distinct dorsal hump on abdominal somite 3 4

2. Long, slender rostrum, substantially exceeding scaphocerite ..... *Palaemon debilis*

— Rostrum at most just exceeding scaphocerite 3

3. Distinct black spot at posterolateral end of sixth abdominal somite; 3 distinct red and blue lines on carapace; 1 transverse line across posterior edge of third abdominal somite ..... *Palaemonetes atrinubes*

— Without black spot at base of sixth abdominal somite ... . *Palaemon* cf. *debilis*

4. Broad, red band across most of palm of pereopod 2; fingers white; abdomen with longitudinal rows of few large spots of red, blue and black chromatophores; distinct longitudinal stripes on carapace ..... *Palaemon serenus*

— Without wide red band or only a narrow one across palm of pereopod 2; if narrow red band present, abdomen with saddle stripes of red on dorsal and lateral surfaces 5

5. Grey or olive-green; distinct wide, grey band across palm of pereopod 2; diffuse longitudinal and oblique rows on carapace; diffuse transverse lines on posterior edges of abdominal articles ..... *Palaemon macrodactylus*

— Without wide grey or olive-green band on palm of pereopod 2 6

6. Saddle stripes of red across back and sides of whole body; less distinct on carapace; palm of pereopod 2 with narrow red band; fingers with similar band half way along .... *Palaemon litoreus*

— Without longitudinal stripes on abdomen 7

7. Distinct red lines either obliquely on carapace or transversely on abdomen 8

— Overall olive-green or brown due to red, white, yellow and blue chromatophores; carapace with diffuse dorsal and anterior bands and indistinct mottling posteriorly; antennule inner flagellum pale red .... *Palaemonetes australis*

8. Distinct transverse red and/or occasionally olive stripes across all abdominal somites; less distinct longitudinal and oblique red stripes on carapace (Fig. 2a, b); antennule inner flagellum pink with few white flecks; often row of white chromatophores along lateral carina of the rostrum ..... *Palaemon dolospina*

— Distinct oblique and transverse red lines on carapace; few scattered red, olive and black chromatophores forming indistinct transverse lines on abdominal segments (Fig. 2c); antennule inner flagellum with definite red and white bars, persisting as purple bars in ethanol-preserved specimens ..... *Palaemon intermedius*

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Linguimaera Pirlot, 1936 (Crustacea, Amphipoda, Melitidae), a valid genus

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Abstract

Krapp-Schickel, T. 2003. *Linguimaera* Pirlot, 1936 (Crustacea, Amphipoda, Melitidae), a valid genus. *Memoirs of Museum Victoria* 62(2): 257–283.

The genus *Maera* sensu lato is among the largest genera in the Melitidae, used as a catch-all for species lacking the defining characters of other genera. Recently, several authors have started splitting this species flock into better-defined genera and the present paper continues this task. It revives *Linguimaera* erected in 1936 by Pirlot, but soon after synonymised again with *Maera*. The most striking characters are a short third article of the mandibular palp, asymmetrical gnathopods in both sexes, epimeral plate 2 with a sinus, epimeral plate 3 serrate on its posterior margin and telsonic lobes asymmetrically incised. Eight species can be attributed to *Linguimaera*, of which seven are new: *L. pirloti* (type species), *L. bogombogo, L. caesaris, L. garitima, L. kellissa, L. leo, L. mannarenis* and *L. tias*.

Key words

Taxonomy, Amphipoda, *Linguimaera*, Indo-Pacific

Introduction

The suspicion that the amphipod family Melitidae may be paraphyletic is not new: Bousfield (1973) conceived it as comprising marine members of Barnard's Gammaridae (Barnard, 1969); neither he nor following researchers could find a single synapomorphy. Thus, genera are grouped on the basis of shared character states which may be homoplasic. Recent results of chromosome research confirmed big differences in chromosome numbers and karyotype-morphology between genera (Libertini and Krapp-Schickel, 2000).

Besides this, within *Maera* Leach, 1814 sensu lato, characters vary significantly. Barnard and Barnard (1983: 623) listed 59 species in their overview of the genus and diagnosed it: "Like *Elasmopus* but article 3 of mandibular palp not falciform. Like *Ceradocus* but inner plate of maxilla 2 lacking facial row of setae; maxillae generally poorly setose medially. Species of *Maera* probably polyphyletic, sources from *Ceradocus, Elasmopus*, *Mallacoota* etc." In recent years, several papers by me and others have started revision of this taxon by defining *Maera* sensu stricto (Krapp-Schickel, 2000; Krapp-Schickel and Jarrett, 2000), and by splitting off clades into new genera (*Quadrimaera* Ruffo and Krapp-Schickel, 2000, *Zygomaera* Krapp-Schickel, 2000 and *Othomaera* Krapp-Schickel, 2000). Here, the process continues and the present paper deals with the validation of *Linguimaera* Pirlot, 1936.

Walker (1904) described a new species of *Maera* found in Ceylon. He offered only small sketches and stressed eight differences from *Maera othonis* Milne Edwards, 1830; he named his species *Maera othonides*. The type material is no longer extant and the description is too poor to give an exact idea about most of the crucial character states. Pirlot (1936) found amphipods during the *Siboga* expedition to Indonesia which he attributed to Walker's species. As he noticed an enlarged sagittal lobe of the labium, he erected a new genus *Linguimaera*, choosing not his material but "*Maera othonides* Walker 1904" as type species. Shortly after, Schellenberg (1938: 49) denied the taxonomic value of the shape of the upper lip at generic level (it occurs also in other species of *Maera* sensu lato), and synonymised *Linguimaera* with *Maera*.

Barnard (1972a: 224) suspected that there might be a group of species closely related to *M. othonides* Walker sensu Pirlot, but opined that the name *Linguimaera* Pirlot unfortunately was not available. In my opinion, Pirlot, who probably never saw Walker's type material of *M. othonides* (which I consider to be a species dubia), wrongly identified his Indonesian material as that species. In reality he based his description of *Linguimaera* on his Indonesian material which in the present paper is described as a new species, *L. pirloti*. According to ICZN (4th edition, 1999) Article 70.3.1, this may now be selected as the type species, replacing the dubious *Maera othonides* Walker chosen by Pirlot.

While studying the rich collections of Museum Victoria, Melbourne, it became obvious to me that *Maera othonides* Walker sensu Pirlot, 1936 shows a series of character states shared with *M. mannarensis* Sivaprakasam, 1968 and with other undescribed species. These peculiarities seem always to occur together, are probably not convergent but are synapomorphies of a clade of related species as Barnard had already surmised.

Abbreviations are as follows: AM, Australian Museum, Sydney; MCNCr, Museo Civico di Storia Naturale Verona; NMV, Museum Victoria, Melbourne; USNM, Naturaly History Museum, Smithsonian Institution, Washington; ZMA, Zoological Museum, Amsterdam.

Symbols used in the figures are as follows: Ep1–3, epimeral plates 1–3; Gn1, 2, gnathopods 1, 2 (l =large, s=small); Hd, head; LL, lower lip; Md, mandible; Mdp, mandibular palp; Mxp, maxilliped; Mx1, 2, maxilla 1, 2; ov., ovigerous; P3–7, pereopods 3–7; T, telson; U1–3, uropods 1–3; UL, upper lip; Us, urosome.

Maera othonides Walker, 1904 species dubia

Maera othonides Walker, 1904: 273, fig. 29

Remarks. The original description of this species from Ceylon is slim. One is required to examine illustrations of *M. othonis* (Milne Edwards) from Europe to make assumptions on characters Walker did not describe other than by "similar to *M. othonis*." He reported a length of 8 mm, article 3 mandibular palp "considerably shorter" than article 2, antenna 1 accessory flagellum with 3 articles, the third pleon segment with no teeth on its lower and 1–3 teeth on the posterior margin, third uropods truncate, telsonic lobes distally incised having one short robust seta sitting there, and a second notch on the inside of the lobe. This description would fit many species of the old *Maera* flock. Another species within this geographical distribution is *Linguimaera mannarensis* but we cannot check the suspicion that the two are the same.

Indian material cited under the same name by Chilton (1921: 535, fig. 5; no body length) could well be the same as that of K.H. Barnard (1935: 285, fig. 5; adults 11 mm) or of Nayar (1959: 26, pl. 8 figs 1–18; up to 12 mm) and is certainly not the species from Ceylon. In this, the antenna 1 accessory flagellum is up to 5 articles, the gnathopod 2 of the female has the palm slightly convex and of the male regularly excavated; the epimeral plate 3 is serrate on the posterior (and inferior) margins; uropod 3 and the posterior portion of the pleon are densely beset with delicate woolly setae; the telson is cleft halfway and its lobes distally pointed, with one long setule and two smaller ones, and no notch on inner margin. The characters of the mandibular palp (article 3 short, although much shorter still than in all *Linguimaera* species here described), the serrate posterior epimeral plate 3, and the lanceolate uropod 3 would match the definition of *Linguimaera*. But all three authors reported a "pubescent" pleon, densely setose uropod 3 and (only Nayar) pleon segments serrate along the posterodorsal margins of the segments. As already surmised by Krapp-Schickel (2000: 432), the citations of Chilton, K.H. Barnard and Nayar are synonyms of *Ceradomaera plumosa* Ledoyer, 1973 and not *Maera othonides* Walker. That species, according to Walker (1904) was "very common" in Sri Lanka. Nor is their material referable to Pirlot's species, *Linguimaera pirloti* sp. nov. For the time being, *Maera othonides* Walker must remain species dubia.

Distribution. Sri Lanka.

Linguimaera Pirlot, 1936

Figure 1

Linguimaera Pirlot, 1936: 309.— Schellenberg, 1938: 49 (synonymy of *Linguimaera* with *Maera*)

Type species. Linguimaera pirloti sp. nov. (=*Maera othonides* Walker sensu Pirlot, 1936), not *Maera othonides* Walker, 1904; herein selected, see ICZN (4th edition, 1999) Article 70.3.1

Diagnosis. Body smooth. Eyes reniform, more than twice as long as wide. Upper lip thickened, in side-view linguiform, lengthened, reaching between peduncles of antenna 2 (Fig. 1); mandibular palp article 1 rounded or subquadrate, distally not produced; article 3 considerably shorter than article 2, maxilla 1 inner plate with 3 robust setae, maxilla 2 not marginally setose. Antenna 1 longer than antenna 2; antenna 1 accessory flagellum of 2–6 articles; antenna 2 peduncle article 2 gland cone not longer than article 3; *Ceradocus*-like cephalic cheek having notch or slit. Coxa 1 anteriorly lengthened, pointed or rounded, posterodistal corner notched. Gnathopod 1 carpus *Ceradocus*-like swollen, with distoinferior margin usually lengthened to short, acute tooth, often hardly visible under dense robust setae; gnathopod 2 sexually dimorphic and asymmetrical in both sexes, palm ornate and excavate. Pereopod 3 equal to or longer than pereopod 4, merus often somewhat swollen; pereopods 5–7 slender, basis clearly longer than wide, often rectolinear with right-angled posterodistal corner, weakly to strongly serrated posteriorly; dactyli simple, with stiff robust seta on inner side functioning like a pincer. Pleon dorsally smooth. Epimeral plates 1, 2 posterodistal corner upwards curved, acute, followed by shallow sinus defined by another acute tooth; epimeral plate 3 posterior margin densely serrate, up to 9–11 teeth; uropod 3 rami much longer than peduncle, richly spinose, robust setae always much shorter than length of rami; telson deeply cleft, lobes characteristically asymmetrically incised, the outer end being longer; robust setae clearly shorter than telson length.

Included species. Linguimaera bogombogo sp. nov., *L. caesaris* sp. nov., *L. garitima* sp. nov., *L. kellissa* sp. nov., *L. leo* sp. nov., *L. mannarensis* Sivaprakasam, 1968, *L. pirloti* sp. nov., *L. tias* sp. nov.

Discussion. Lowry et al. (2001) redescribed *Megamoera mastersii* Haswell, 1879 from type material and figured round, not sexually dimorphic, eyes and symmetrical not sexually dimorphic gnathopods. They also redescribed *Moera hamigera* Haswell, 1879 on the basis of abundant recent collections. The latter is obviously a common species on Australian coasts which nevertheless totally seems to have escaped collecting in the last 130 years. It has different second epimeral plates, third uropods and telsonic lobes. Lowry et al. (2001) also redescribed *Megamoera boeckii* Haswell, 1879 with an emarginate telson shorter than broad. All these species do not seem to be closely related to the species flock presented here.

The genus *Anamaera* Thomas and Barnard, 1985 (from Florida, Thomas and Barnard, 1985) appears to be similar to *Linguimaera* also having asymmetrical gnathopod 2 and the same epimeral shape. But the mandibular palp article 3 is not shorter than article 2 and the eyes are rounded. *Maera williamsi* Bynum and Fox, 1977 was given erroneously as a synonym of *Anamaera hixoni* Thomas and Barnard, 1985 by Krapp-Schickel and Jarrett (2000) but has since been recognised as distinct. Another species remains to be described.

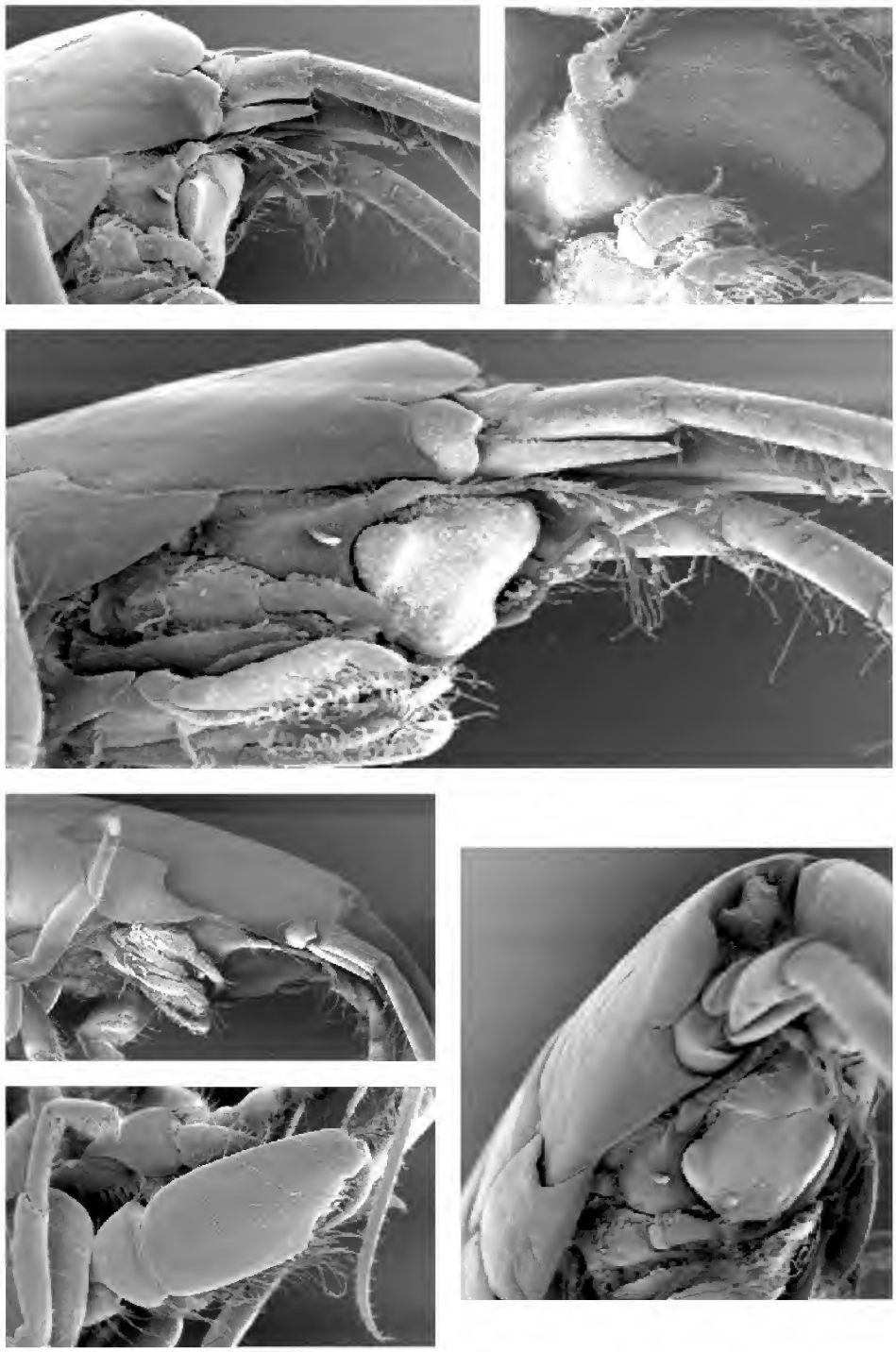

Figure 1: *Linguimaera* sp. male (Adelaide, South Australia) SEM pictures. Above: head with thickened upper lip laterally; mandible with palp, maxillae; left half of upper lip ventrally. Second line: head with antennae, upper lip, mandible with palp, maxillae and maxilliped ventrolaterally. Below: head with first coxae and mouthparts from lateral and ventral; gnathopod 2 male.

Ceradomaera Ledoyer, 1973 also has asymmetrical second gnathopods and differs mainly in the emarginate telson and dorsal teeth.

Serrations on epimeral plate 3, both below and above the posteroventral tooth, also occur in other species of *Maera* sensu lato (e.g. *Othomaera othonis* (Milne-Edwards, 1830), *Quadrimaera serrata* (Schellenberg, 1938), *Maera tepuni* Barnard, 1972), but extra teeth defining an excavation on epimeral plate 1 and (more clearly visible in) epimeral plate 2, appear to be confined in the Indo-Pacific to *Linguimaera*, and in the Atlantic to *Anamaera* and the *Maera williamsi*-clade.

Barnard (1972a) cited also *Maera othonopsis* Schellenberg, 1938 in connection with the present species flock. It was described with few figures on the basis of only two incomplete ovigerous females from the Gilbert Is (Tropical West-Pacific) as having subequal mandibular palp articles 2 and 3, quite different third uropods and telson (cf. *Quadrimaera* Ruffo and Krapp-Schickel, 2000 or *Mallacoota* Barnard, 1972), and was never found again. It certainly does not belong to *Linguimaera*.

The Indo-Pacific genus *Linguimaera* is well differentiated from other genera of this region (*Quadrimaera, Ceradocus* Costa, 1853, *Elasmopus* Costa, 1853, *Maeracoota* Myers, 1997, *Mallacoota*) by asymmetrical second gnathopods in both sexes, a sinus on the posterodistal corner of the first and second epimeral plates and a serrate posterior margin on the third epimeral plate. It shares the asymmetry of the gnathopods with the Atlantic *Anamaera* and the Indopacific *Zygomaera* Krapp-Schickel, 2000, but differs mainly by characters of the mandible (palp articles 2 and 3 subequal) and telson (in *Anamaera* lobes cuspidate, in *Zygomaera* lobes partly coalesced). The *Maera* sensu lato flock of Barnard and Barnard (1983), containing 59 species, is now mostly unravelled, but there are still a dozen species remaining in *Maera* sensu lato, thereby stressing that they do not belong to the well-defined *Maera* sensu stricto.

Key to genera similar to *Linguimaera*

1. Gnathopod 2 asymmetrical 2
— Gnathopod 2 symmetrical 5
2. Telson fused halfways or more, distally only emarginate 3
— Telson deeply cleft 4
3. Metasome and urosome minutely toothed dorsally, beset with plumose setae; mandibular palp article 3 as short as article 1 . . . . . *Ceradomaera*
— Metasome and urosome smooth; mandibular palp article 3 clearly longer than article 1 . . . . . *Zygomaera*
4. Eyes round, mandibular palp article 2 equal to article 3, distal robust setae of telson longer than telson length . . . . . *Anamaera*
— Eyes reniform, mandibular palp article 3 shorter than article 2, distal robust setae of telson shorter than telson length . . . . . *Linguimaera*
5. Dorsally carinate or toothed 6
— Dorsally smooth 8
6. Gnathopod 2 palmar corner rectangular, urosomites 1, 2 with dorsal teeth . . . . . *Maeracoota*
— Gnathopod 2 palmar corner absent or less than 90° . . . 7
7. Epimeron 3 smooth or carinate, urosome carinate . . . . . *Mallacoota*
— Epimeron 3 with serrations, urosome smooth . . . . . *Parelasmopus*
8. Mandibular palp article 3 falcate . . . . . *Elasmopus*
— Mandibular palp article 3 linear 9
9. Mandibular palp article 1 distally tooth-shaped, lengthened 10
— Mandibular palp article 1 rounded 11
10. Gnathopod 2 dactylus outer margin densely setose; maxillae not fully setose . . . . . *Maera*
— Gnathopod 2 dactylus outer margin with 1 seta; maxilla 1 inner plate fully setose, maxilla 2 with oblique facial row of setae . . . . . *Ceradocus*
11. Pereopod 5 basis not longer than coxa 5; uropod 3 very short, rami scarcely longer than peduncle . . . . *Lupimaera*
— Pereopod 5 basis longer than coxa 5; uropod 3 rami clearly longer than peduncle 12
12. Gnathopods 2 without palmar corner, dactyli smooth; uropod 3 lanceolate, medially widened, distally pointed . . . . . *Othomaera*
— Gnathopod 2 distally widened, palmar corner well defined 13
13. Palmar corner subrectangular, pereopod 5-7 dactylus simple, uropod 3 slightly unaequiramous . . . . *Maeropsis*
— Palmar corner rectangular, pereopods 5–7 with bifid dactylus, uropod 3 aequiramous . . . . . *Quadrimaera*

Key to species of *Linguimaera*

1. Telson distal robust setae longer than half telson length; gnathopod 2 male palm transverse . . . . . *L. garitima* (300 m depth, Australia)
— Telson distal robust setae equal or shorter than half telson length; gnathopod 2 male palm oblique 2
2. Uropod 3 ratio peduncle : rami greater or equal to 2.5 . 3
— Uropod 3 ratio peduncle : rami less than 2.5 5
3. Longest distal robust seta on telson equal to half telson length; male gnathopod 2 palmar corner thumb-shaped . . . . . *L. leo* (shallow water, Australia)
— Longest distal robust seta on telson shorter than half telson length; male gnathopod 2 without thumb 4
4. Male gnathopod 2 palm J-shaped excavated, palmar corner sharp . . . . . *L. kellissa* (infralittoral, Australia)
— Male gnathopod 2 palm oblique, neither excavated nor convex, without palmar corner . . . . . *L. pirloti* (infralittoral, Indonesia)
5. Male gnathopod 2 palm with deep U-shaped excavation, dactylus strongly inwards bent . . . . . *L. mannarensis* (no depth reported, India)
— Male gnathopod 2 palm with excavation, not U-shaped 6
6. Male gnathopod 2 propodus palm with V-shaped incision near palmar corner; pereopods 5–7 very strong, posterodistal corner lengthened and broadened, pereopod 7 propodus widened . . *L. bogombogo* (littoral, Micronesia)
— Male gnathopod 2 propodus palm with shallow semicircular excavation; pereopods 5–7 slender 7

7. Male gnathopod 1 propodus more than twice as long as wide; pereopod 7 basis posterior margin straight, posterodistal corner with right angle ..... *L. tias* (infralittoral, Australia and New Zealand)
— Male gnathopod 1 propodus twice as long as wide; pereopod 7 basis posterior margin and posterodistal corner rounded ..... *L. caesaris* (littoral, eastern Mediterranean, Red Sea)

Linguimaera pirloti sp. nov.

Figure 2

Linguimaera othonides.— Pirlot, 1936: 309–311, fig. 132.

Material examined. Holotype. Sulawesi, Sailus ketjil, Iles Paternoster, 27 m depth, corals and sand, 30, 31 Mar 1899 (*Siboga* Expedition stn 37), ZMA Amph. 204584 (1 male, 7.1mm on 2 slides).

Paratypes. Détroit de Molo, 54–90 m, sand, 19 Apr 1899 (Siboga Expedition stn 51) ZMA Amph. 204585 (4 females, all on slides; 11 inadults in alcohol). 4°20′S, 122°58′E, sand and shells, 20 Sep 1899, 75–94 m (*Siboga* Expedition stn 204), ZMA Amph. 204586 (2 males, 1 adult female, partly on slides).

Diagnosis. Female gnathopod 1 propodus ratio of length : width = 3, in male = 2; palm not defined, posterior margin regular; palmar corner proximally followed by shallow excavation. Gnathopod 2 in both sexes similar in shape, but asymmetrical; in female palmar excavations deeper. Pereopod 7 basis ratio of length : width = 1.25. Telson with 2 or 3 distal robust setae, maximum lengths half length of telson.

Description. Adult male and female 6–7.1 mm.

Head: lateral cephalic sinus anteroventral corner blunt, nearly right-angled. Eyes with upper half narrower. Coxae 1–4 with small notch posterodistally.

Antenna 1 peduncle with 1 robust seta on article 1 distally; peduncle article 1 subequal article 2; article 3 about one third of article 1; accessory flagellum of 3–4 articles; antenna 2 slender, gland cone short, peduncle reaching end of antenna 1 peduncle; article 4 longer than article 5, flagellum as long as article 5, of about 12–14 articles.

Mandibular palp article 1 longer than wide; ratio of article 2 : article 1 = 3.6; article 2 : article 3 = 1.3; article 2 with 4 long setae but no groups of setae along margin; article 3 with 8 long setae. Mandibular incisor, lacinia mobilis and molar with medium sized blunt teeth. Molar medium Labium with rounded inner lobes, outer ones densely setose. Maxilla 1 unknown. Maxilla 2 outer plate wider than inner plate, outer plate 8 robust setae only distally, no setae marginally. Maxilliped unknown.

Gnathopod 1 weakly sexually dimorphic. Coxa 1 anteriorly acutely produced. Basis ratio length : width = 3, anterior margin with 3 long setae, posteriorly more and longer ones; merus posteroventrally with acute tooth; carpus with nearly parallel margins, length to width about 2.5, with stiff marginal and submarginal robust setae; propodus in female slim, narrower than carpus, ratio length : width= 2.5–3.0, in male wider, twice as long as wide, in both palm not defined.

Gnathopod 2 of *female* slightly asymmetrical in size, similar in shape. Coxa 2 longer than wide, basis with few short setae on anterior margin, many very long ones on posterior margin; merus posterodistally with acute tooth; carpus posteroventral corner rounded; length ratio carpus : propodus = 0.8, about same width; propodus slender, ratio length : width = 2.5–3.0, palm concave, weakly defined by corner; 1 subdistal prominent robust seta on the inner surface next to the palmar corner, 2 smaller ones along the palm. Gnathopod 2 of *male* dimorphic both in size and shape: the smaller is as described for the female, the other has a longer, less excavated palm. Dactylus not much curved.

Pereopods spinose, propodus longer than merus, carpus shorter, length of basis : propodus = 1.3; basis posterior margin serrate, posterodistal corner somewhat lengthened. Dactyli forming a "chela" with their nail and the stiff, towards the dactylus bent robust seta on inner margin.

Epimeral plates 1, 2 posteroventral corners acute, followed by a shallow short sinus ending with a blunt tooth. Epimeral plate 3 with up to 9 small teeth on posterior margin, in adult males many irregular teeth, in juvenile specimens less; ventral margin smooth.

Uropod 2 the shortest, uropod 3 extending much more than uropod 1; uropod 1 peduncle longer than rami, 1 sub-basofacial strong curved robust seta in about one third of length on outer margin, 1 very long robust seta subdistally; inner ramus longer than outer one. Uropod 2 distally with 2 longer and some shorter robust setae. Uropod 3 ratio peduncle : rami less than 0.5, rami subequal, outer somewhat narrower than inner one; 1 article; both distally tapering, scarcely truncate, with 2–3 distal robust setae, marginal ones on outer ramus in 3–4 groups, on inner one many short single ones.

Telson, inner side shorter and outer corner acutely prominent; in the excavation 2–3 strong robust setae (0.2–0.5 of telson length).

Etymology. Dedicated to J.M. Pirlot.

Distribution. Sulawesi, Indonesia; coral rubble, shells, sand, 27–94 m.

Remarks. The "disproportionate" insertion between propodus and carpus, which Barnard (1972a: 126) stressed for this species flock, and which leads to a deeper "gap" dorsally in other species, is here very scarcely visible.

Linguimaera bogombogo sp. nov.

Figures 3–4

Maera hamigera.—Barnard, 1965: 507–510, fig. 16.
?*Maera* species A.—Barnard, 1970: 158, fig. 98, 99
(not *Maera hamigera* Haswell, 1879a: 333, pl. 21 fig. 1)

Material examined. Holotype. Eniwetok Atoll, Bogombogo Island, Micronesia, USNM 108926 (male, 4.3 mm).

Paratype. Eniwetok Atoll, Bogombogo Island, Micronesia, USNM 108926 (ovigerous female, 5.2 mm).

Other material. Eniwetok Atoll, Igurin I., lagoon side, alga *Bryopsis* sp., attached to rocks, 27 Sep 1956, USNM 108928 (male 5 mm, drawn by Barnard, 1965; 2 ovigerous females 5 mm, 4.3 mm, immature and juvenile, incomplete). Igurin I., lagoon side, preserved rocks, 27 Sep 1956, USNM 108949 (1 juvenile). Igurin I., lagoon side, sand washings from under rocks, 27 Sep 1956, USNM 108927 (1 male? 3.5 mm,

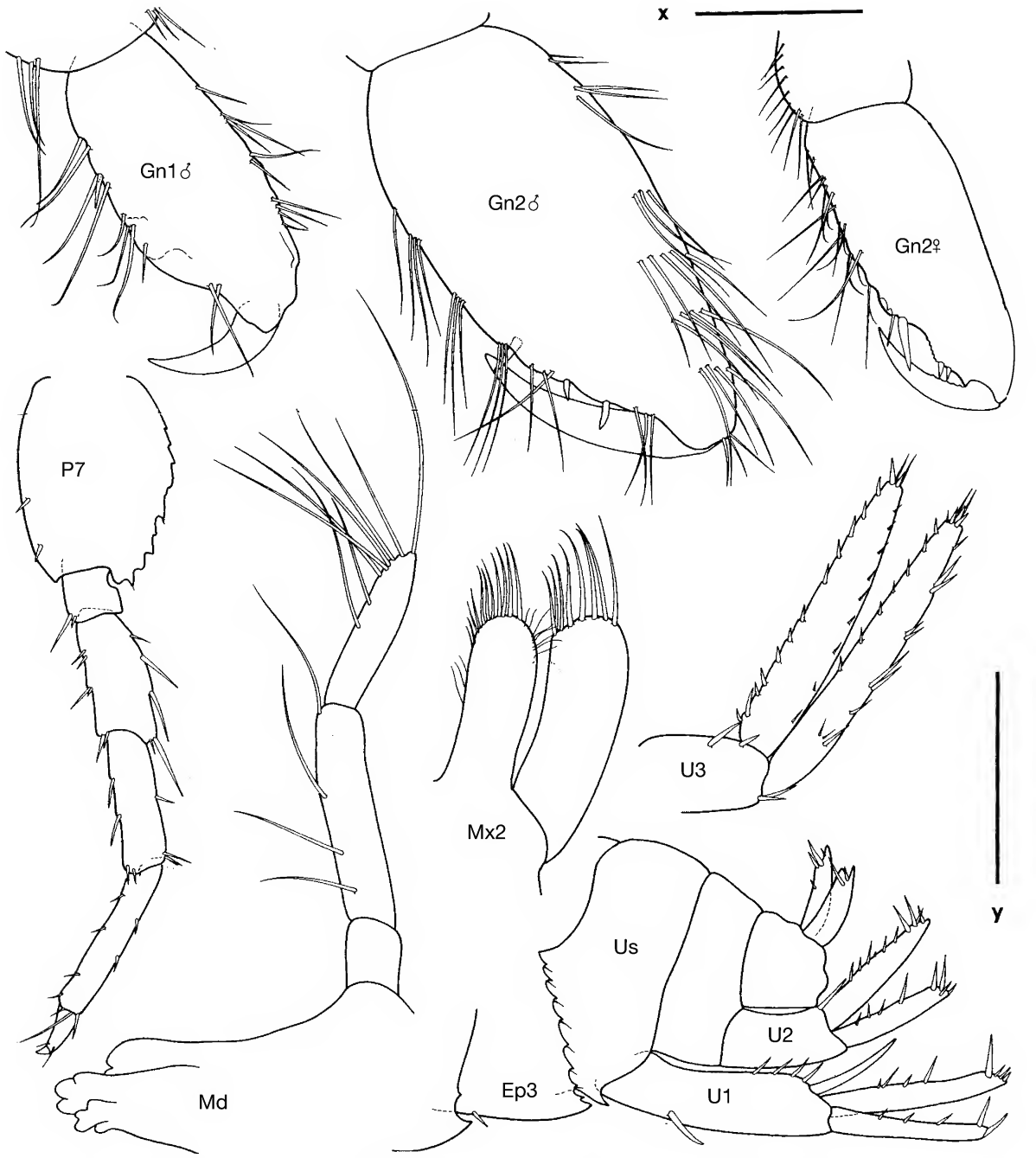

Figure 2. *Linguimaera pirloti* sp. nov., male, female (Sri Lanka). Gn2 female, Us, U3 in scale x = 0.5 mm; Gn 1,2 male in scale x = 0.25 mm; P7 in scale y = 1 mm; Md, Mx2 in scale x = 0.2 mm.

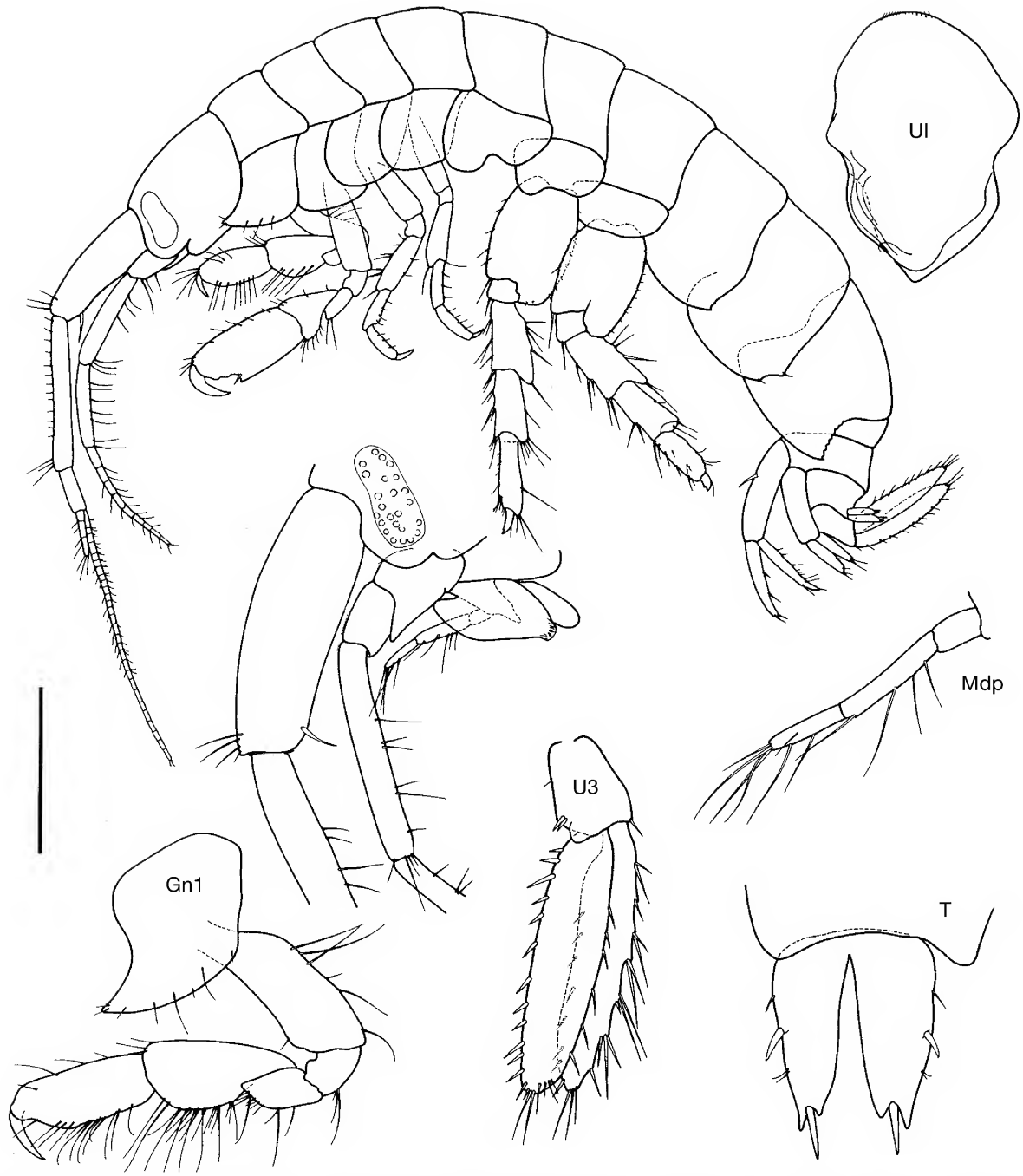

Figure 3. *Linguimaera bogombogo* sp. nov., male, female (Eniwetok Atoll, Bogombogo Island, Micronesia). Hd, Gn1, U3 in scale = 0.33 mm; Mdp, UL, T in scale = 0,175 mm.

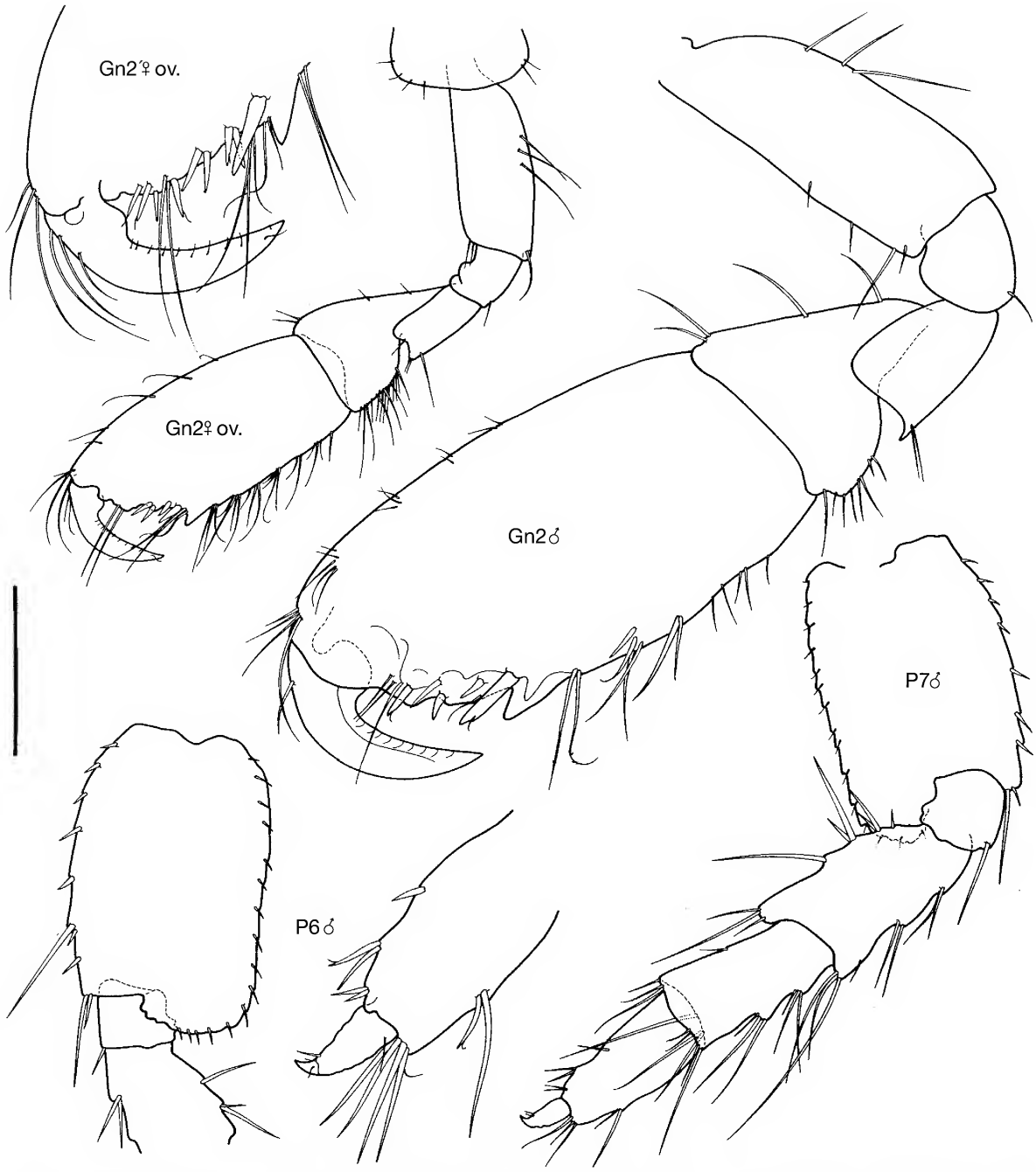

Figure 4. *Linguimaera bogombogo* sp. nov, male, female (Eniwetok Atoll, Bogombogo Island, Micronesia). Gn2 female in scale = 0.25 mm; Gn2 male, Gn2´ female in scale = 0.125 mm; P6, 7 in scale = 0.175.

1 specimen 3 mm, 3 juveniles). Boden I., ocean side, 12 Oct 1956, USNM 108929 (1 specimen 3.3 mm)..

Diagnosis. Gnathopod 1 propodus rectangular, twice as long as wide, palm oblique, straight. Gnathopod 2 male palm well defined as acute tooth, followed by V-shaped incision; palm with small shallow excavations. P7 rectangular, widened and posterodistally lengthened, ratio length : width = 1.5. Telson with 1 distal strong robust seta of about one third of telson length.

Description. Ovigerous female 5–5.5 mm, male 4–5 mm.

Head about same length as first 2 body segments. Lateral cephalic lobes rounded, with notch, anteroventral corner rounded. Eyes narrowed in middle.

Antenna 1 about 0.6 body length, peduncle = flagellum, peduncle article 1 shorter than article 2; flagellum of up to 25 articles, accessory flagellum of 3–4 articles; antenna 2 slender, gland cone reaching about half of peduncle article 3, article 4 longer than article 5, flagellum longer than peduncle article 5, of 8 articles.

Mandibular palp article 1 clearly longer than wide; ratio article 2 : article 3 = 1.4, article 2 with 4 long setae, article 3 distally 4 setae, laterally 2–3.

Gnathopod 1 not sexually dimorphic. Coxa 1 anterodistally lengthened and pointed. Basis ratio length : width = 3, posteriorly 5-6 long setae. Merus posteroventrally rounded, characteristical pointed tooth lacking, ratio length : breadth less than 2; carpus triangular, ratio length : breadth= 2.3; propodus rectangular, less broad than carpus, ratio length : breadth= 2.3, palm defined, oblique.

Gnathopod 2 of *female* slightly dimorphic in size and shape. Coxa 2 quadrangular, basis with few long setae on posterior margin, merus posterodistally with tooth; carpus triangular, ratio length : breadth= 1.45, carpus: propodus = 0.55, both about same width; propodus slender, similar shape to male, but narrower; anterior and posterior margin parallel, palm defined by prominent tooth and beset with strong robust setae, anterior : posterior margin = 4:3. Smaller gnathopod 2 lacking prominent defining tooth, longer and narrower. Gnathopod 2 of *male* strongly dimorphic, carpus in larger gnathopod shorter, length subequal to width. Both propodi similar to female, but larger one more broadened and defining tooth as well as robust seta sitting next to it more developed.

Pereopods 3, 4 similar in shape and size. Pereopods 5–7 robust, basis rounded, very small serrations on posterior margins. Pereopod 6 the longest, in pereopod 7 the propodus shortened and thickened. Dactylus with uneven outer and inner margins, distally on inner one 1 stiff seta and one short and thin next to it.

Epimeral plate 3 with small dense serration.

Uropod 1 peduncle inferior margin on proximal third with 1 strong robust seta, subequal rami shorter than peduncle; uropod 2 subequal rami shorter than peduncle; uropod 3 rami subequal distally rounded, beset with many robust setae being maximally of a quarter of ramuslength.

Telson longer than wide, lobes outer end longer than inner one; in excavation 1 strong robust seta inserted, about one third of telson length. Outer margin about halfways another, somewhat shorter robust seta, distally 1-2 fine setae, proximally a stiff robust seta.

Etymology. From the island where the type specimens were found (noun in apposition).

Distribution. Eniwetok Atoll (Micronesia); green algae (*Bryopsis, Caulerpa, Halimeda*) and surrounding sand of rocky intertidal; wash of old coral heads in about one-third metre of water, together with amphipods *Cymadusa filosa, Elasmopus pseudaffinis, Gammaropsis digitatus, G. pacificus, Lembos aequimanus, L. bryopsis, L. cf. intermedius, Quadrimaera serrata, Mallacoota cf. insignis, Paragrubia vorax.*

Discussion. This species clearly belongs to this clade, having bean-shaped eyes, a (not very pronounced, but present) notched cephalic lobe, mandibular palp article 3 much shorter than article2, coxa 1 anteriorly acutely lengthened, gnathopod 1 carpus thickened, gnathopod 2 asymmetrical, epimeral plates 1–3 with characteristic excavations or serrations, uropod 3 rami long and with many short robust setae, telsonic lobes distally incised.

Linguimaera caesaris sp. nov.

Maera hamigera. —Walker, 1909: 335, pl. 43, fig. 5.—Karaman and Ruffo, 1971: 152–158, figs 21–23.—Lyons and Myers, 1993: 587, fig. 10.

(not *Maera hamigera* Haswell 1879a: 333, pl. 21, fig. 1)

Material examined. Holotype. Cesarea, Mediterranean coast of Israel, MCNCr 425 (ovigerous female 8.5 mm).

Paratype. Same locality, MCNCr 1209–1212 (male 6 mm).

Diagnosis. Gnathopod 1 propodus rectangular, less broad than carpus, 3 times as long as large. Gnathopod 2 male, female propodus oval, palm one third of posterior margin, slightly excavated and defined by blunt to rectangular corner. Pereopod 7 basis oval, posterior margin with fine serration. Telson with 1 bigger and 2 tiny robust setae distally, maximum length about one third of telsonic length.

Description. Adult female 8.5 mm, male (immature?) 6 mm.

Head: lateral cephalic lobes rounded, anteroventral corner rounded. Eyes more than twice as long as large, upper part narrowed.

Antenna 1 peduncle scarcely longer than flagellum, peduncle article1 shorter than article 2; flagellum of up to 28 articles, accessory flagellum of 5 articles; antenna 2 slender, gland cone short, article 4 longer than article 5, flagellum subequal to peduncle article 5, of 9 articles.

Mandibular palp article 1 longer than wide; article 2 : article 3 = 2, both with long setae, article 3 also distally.

Coxa 1 anterodistally a bit upturned, bluntly pointed, posterodistal corner with small notch. Basis ratio length : breadth = 3, posteriorly 5 long setae. Merus posteroventrally rounded, (sharp tooth lacking here), less than twice as long as wide; carpus triangular, swollen; propodus rectangular, less broad than carpus, about 3 times as long as wide, palm defined, oblique.

Gnathopod 2 of *female* slightly dimorphic in size and shape. Coxa 2 rectangular, basis with 9 long setae on posterior margin,

merus posterodistally with sharp tooth; carpus triangular, ratio length : breadth = 1.5, carpus: propodus = 3:5, both about same width. Propodus slender, similar shape to male, but shorter; anterior : posterior margin = 5 : 3; palm defined by blunt corner beset with groups of robust setae, proximal part shallow excavate, in distal third defined by strong robust seta sitting elevated. The other gnathopod 2 lacks the palmar excavation as well as the defining robust seta near dactylus insertion and is narrower. Gnathopod 2 of *male* strongly dimorphic, carpus in larger gnathopod shorter, length subequal to width. Both propodi similar to female, but larger one broader, palmar defining tooth well developed, hump defining the palmar excavation more developed.

Pereopods 3, 4 very similar in shape and also size. Pereopods 5–7 robust, basis rectangular, small serrations on posterior margins; pereopod 5 small; pereopods 6, 7 subequal. Dactylus distally on inner margin with 2 stiff setae bent to tip of nail.

Epimeral plate 3 with serration of 4 or 5 teeth.

Uropod 1 peduncle inferior margin subproximally with 1 strong robust seta, subequal rami shorter than peduncle; uropod 2 with subequal rami as long as peduncle; uropod 3 peduncle less than half length of rami, rami subequal, beset with many short robust setae of maximally one seventh ramus length.

Telson longer or subequal to width, lobes outer end longer than inner one; in excavation 1 strong robust seta inserted with small additional ones, robust seta about one third of telson length. On outer margin of first and second third, another shorter robust seta.

Etymology. There are two reasons for the choice of this name: at first sight, because the Mediterranean material (see Karaman and Ruffo, 1971) comes from Cesarea (Israel), but more importantly it should remind of Sandro Ruffo, the grand old man and "emperor" (= caesar) of amphipodologists.

Distribution. Suez Channel (Walker, 1909); Mediterranean coast of Israel; Red Sea: Gulf of Aqaba (Karaman and Ruffo, 1971: 158; Lyons and Myers, 1993: 587–590); 4–5 m, coral rubble (Lyons and Myers, 1993).

Discussion. Figures and description of Ledoyer (1982: 523–527) match perfectly with the ones given by Karaman and Ruffo (1971), except the fact that the telson of the Madagascar material shows on the inner side of the lobes some short robust setae, which lack in the figures of Karaman and Ruffo (1971) and the ones by Lyons and Myers (1993).

Linguimaera garitima sp. nov.

Figures 5–7

Material examined. Holotype. Australia. Tasmania, eastern Bass Strait, 82 km ENE of North Point, Flinders I. (39°27.7′S, 148°41.4′E), 293 m, coarse sand, naturalist's dredge, G.C.B. Poore on HMAS *Kimbla*, 28 Mar 1979 (stn BSS 36), NMV J52321 (1 male 7 mm).

Paratype. Collected with holotype, NMV J52322 (1 female 7 mm).

Other material. Collected with holotype, NMV J20371 (8 males, 16 females 17 juveniles).

Diagnosis. Similar to *L. leo* sp. nov. but: body smaller, articles narrower, coxa 1 anterodistally more lengthened and anteriorly excavated, gnathopod 1, 2 propodus rectangularly narrow, setae long, gnathopod 2 male the smaller ones similar to gnathopod 2 female in totally lacking palmar tooth; pereopod 7 basis about twice as long as wide. Telson about as long as wide, distal strong robust seta between half and two thirds of telsonlength.

Description. Adult male, female 5.5–8 mm.

Head: lateral cephalic lobes rounded, anteroventral corner rectangular. Eyes more than twice as long as large, upper part narrowed.

Antenna 1 peduncle scarcely longer than flagellum, peduncle article1 shorter than article 2; flagellum of up to 34 articles, accessory flagellum of 6 articles; antenna 2 gland cone short, article 4 longer than article 5, flagellum subequal to peduncle article 5, of 9 articles.

Mandibular palp article 1 longer than wide; article 2 : article 3 = 1.6, both with long setae, article 3 also distally.

Coxa 1 anterodistally acute and anteriorly excavated; gnathopod 1 propodus narrow, more than twice as long as wide.

Gnathopod 2 of *female* with narrow and long propodus lacking a defining tooth on the palmar corner, with palm oblique, crenulate. Gnathopod 2 of *male* propodus palm almost transverse, blunt robust defining tooth on (about rectangular) palmar corner; ratio of propodi gnathopod 1 : gnathopod 2 = 0.5.

Pereopods 3, 4 merus not widened; female pereopod basis narrower.

Uropod 1 peduncle as long as rami.. Uropod 3 rami with thinner robust setae.

Telsonic lobes with long robust seta which is clearly longer than half telsonlength.

Etymology. During my stay at Museum Victoria, Melbourne, Gary Poore and Tim O'Hara were extremely helpful on many occasions, and furthermore were strongly involved in the collection of the material. The specific epithet is a combination of their names and expresses my gratitude; used as an adjective.

Distribution. Bass Strait, coarse shell, 293 m.

Discussion. This clade seems strikingly conservative and though checking very thoroughly, there are not many easy characters separating this species from the much shallower *L. leo* (if not dealing with mature males), except: much greater depth, smaller body size, mandibular palp ratio article 2 to article 3 longer (1.65 vs 1.8 in *L. leo*), palmar corner of male gnathopod 2 with about right angle (vs oblique) and (most reliable character) a long robust seta on telsonic lobes (much shorter in *L. leo*).

Linguimaera kellissa sp. nov.

Figures 8, 9

Material examined. Holotype. Australia. Victoria, eastern Bass Strait, 8 km S of South East Point, Wilsons Promontory (39°12.9′S, 146°27.3′E), 65 m, medium sand, R.S. Wilson on RV Tangaroa, 18 Nov 1981 (stn BSS 180), NMV J20370 (1 male 5 mm).

Paratype. Vic., eastern Bass Strait, 11.2 km E of eastern edge of Lake Tyers (37°51.41′S, 148°13.16′E), 32 m, sand-shell, Smith-McIntyre grab, Marine Science Laboratories, 25 Sep 1990 (stn MSL-EG 27), NMV J25482 (1 male 7 mm).

Other material. Vic., eastern Bass Strait, 8 km S of South East Point,

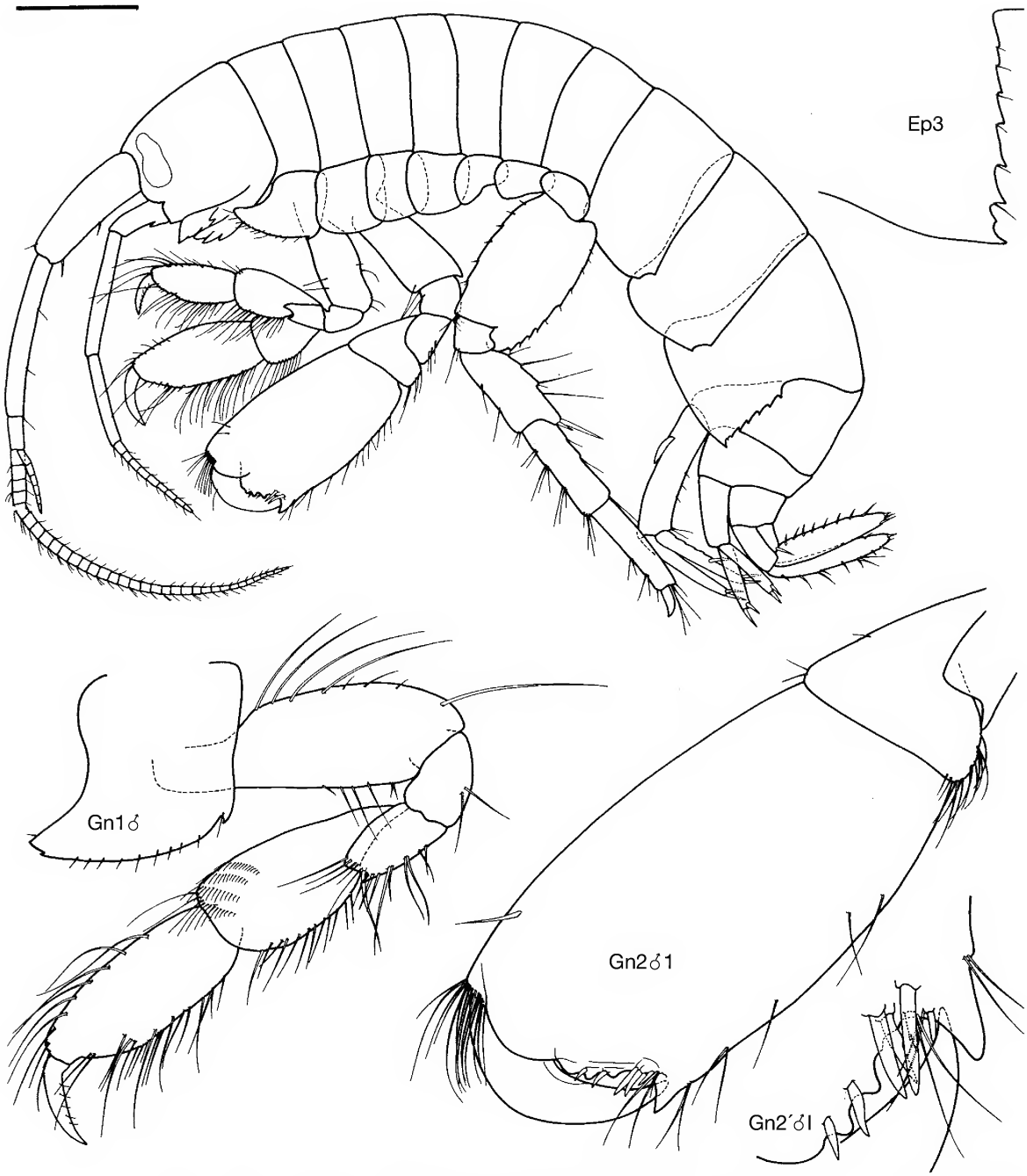

Figure 5. *Linguimaera garitima* sp. nov. (Tasmania). Habitus in scale = 1 mm; Gn1, Gn2 male large and Ep3 in scale = 0.4 mm; Gn2′ male large in scale = 0.2 mm.

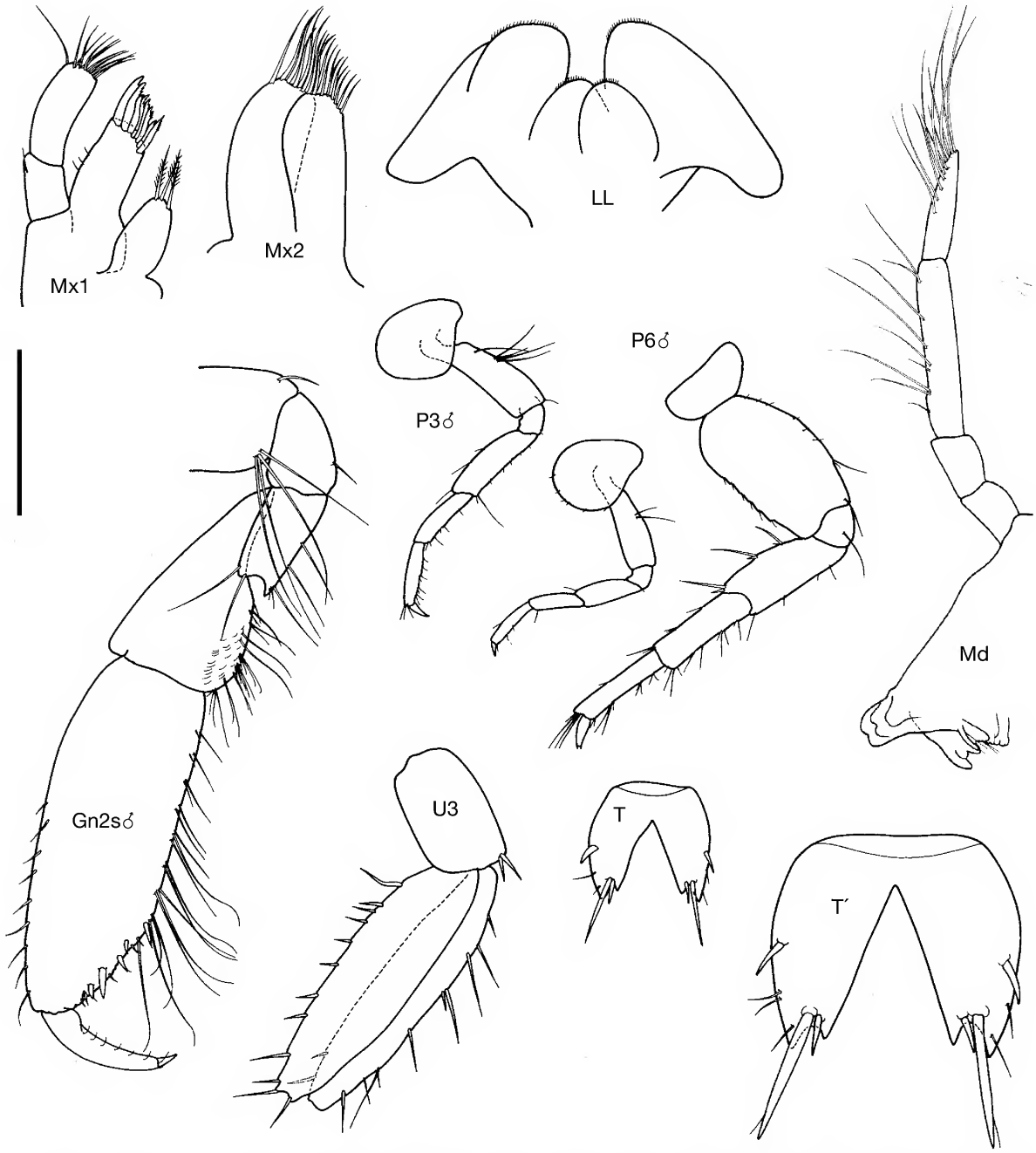

Figure 6. *Linguimaera garitima* sp. nov. (Tasmania). Mx1, 2; Md, LL, T´ in scale = 0.25 mm; P3, 4, 6 in scale = 1.25 mm; Gn2 small male, U3, T in scale = 0.5 mm.

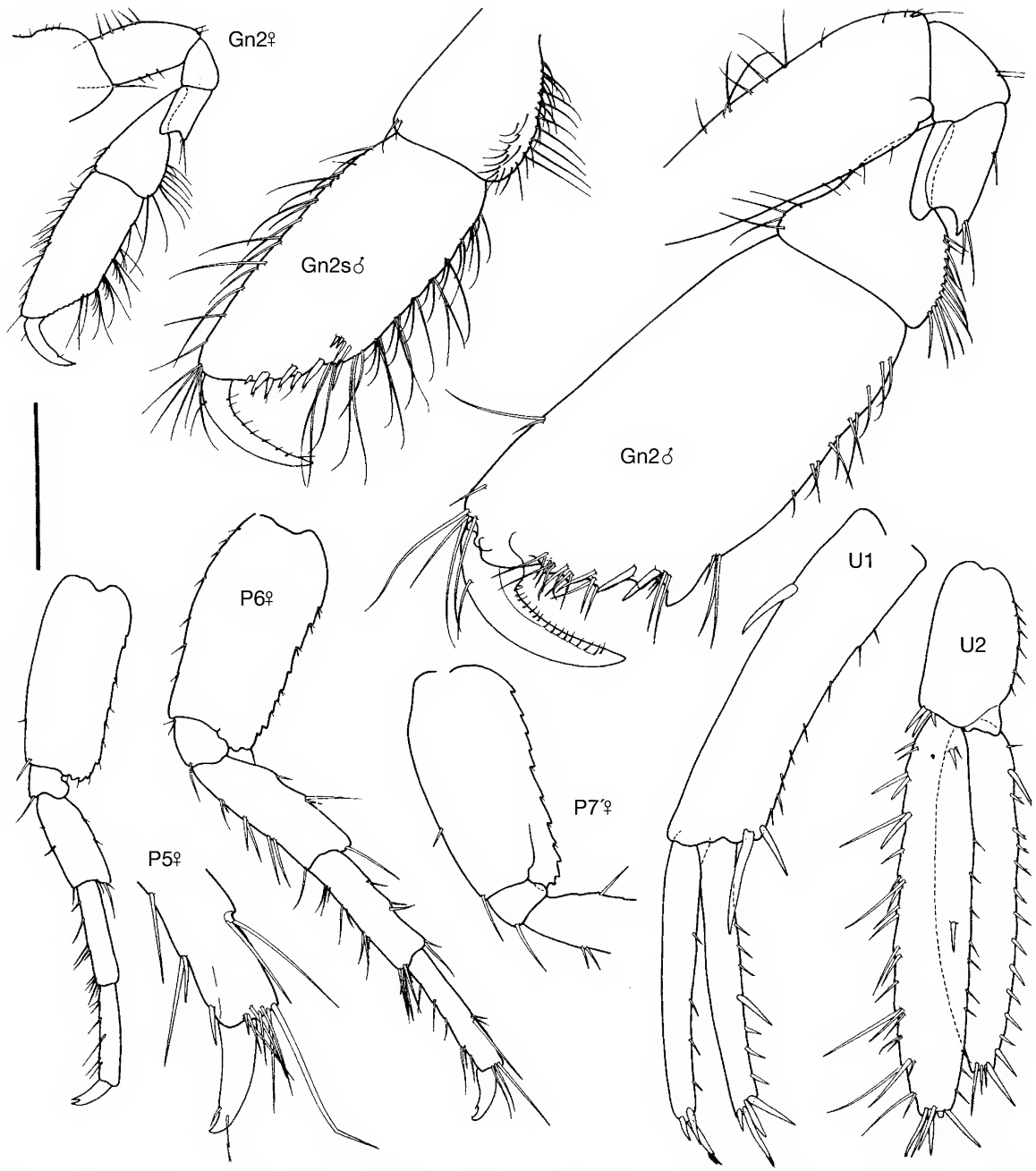

Figure 7. *Linguimaera garitima* sp. nov. (Tasmania). Gn2 male large, Gn2 male small; U1, U3 male, P7′ female 8.5 mm in scale = 0.5 mm; Gn2 female, P5–7 female in scale = 1.25 mm.

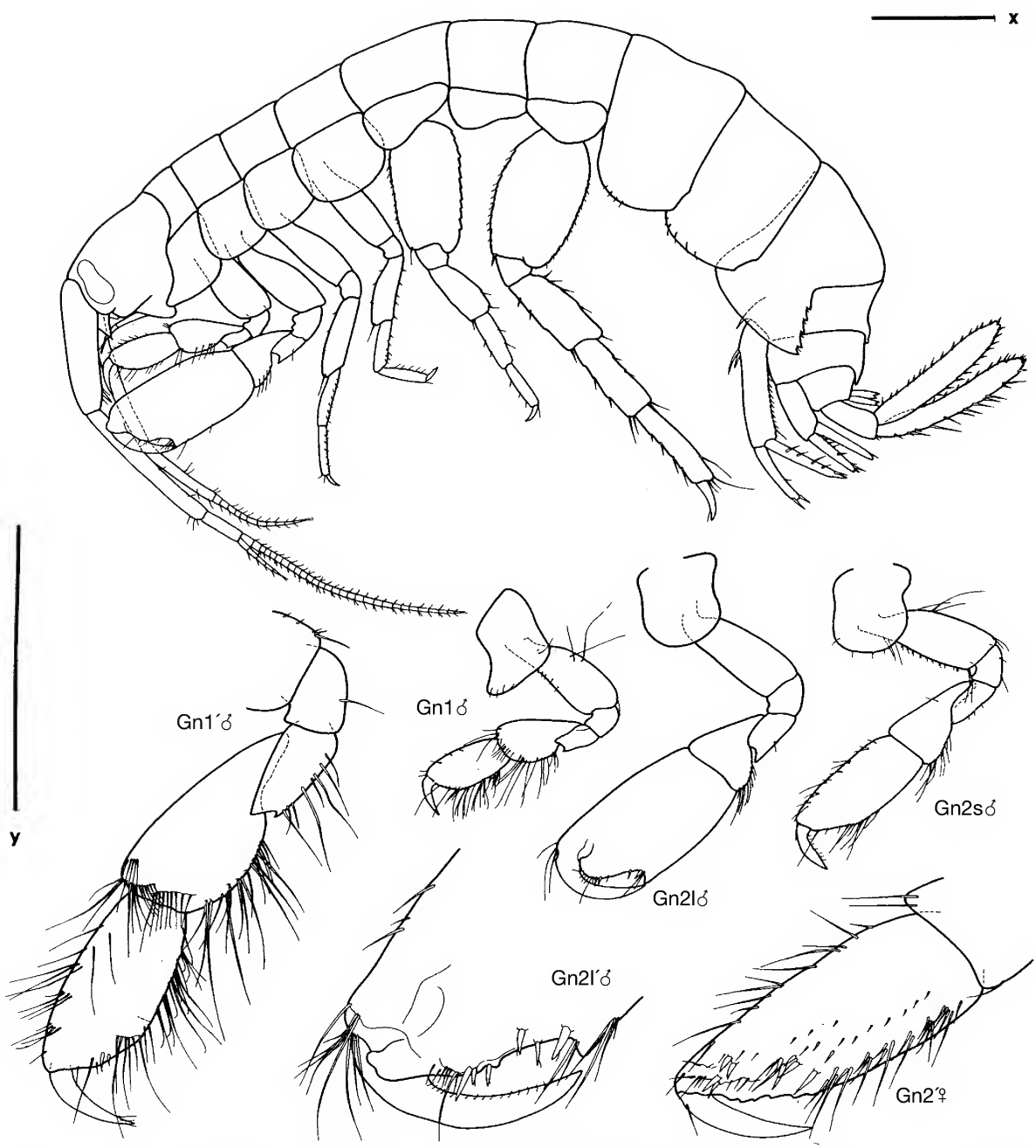

Figure 8. *Linguimaera kellissa* sp. nov. (eastern Bass Strait). Gn1 male, Gn2s male, Gn2 1 male in scale x = 1 mm; Gn1´ male, Gn2´ female, Gn2 l´ male in scale y = 1 mm.

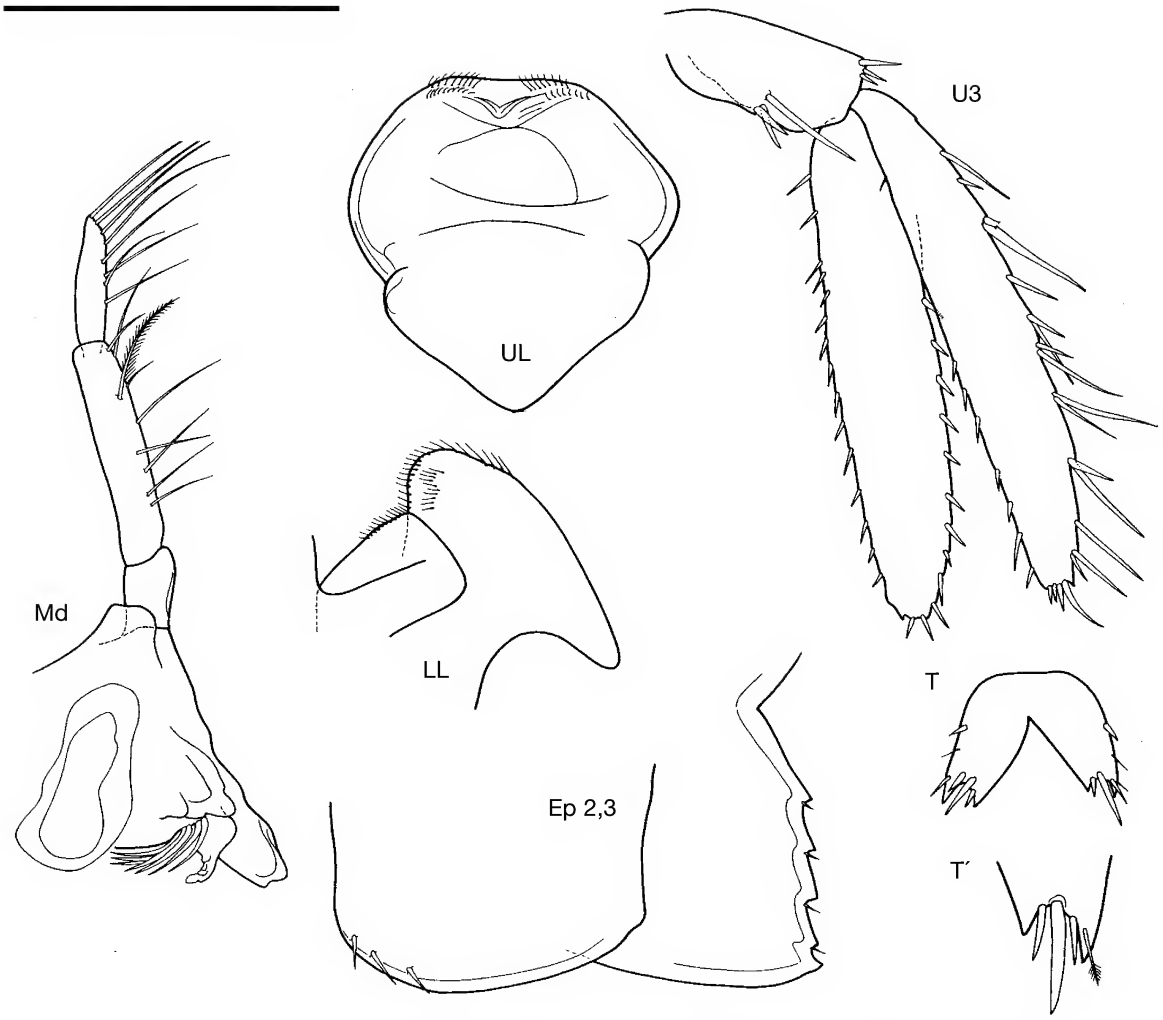

Figure 9. *Linguimaera kellissa* sp. nov. (eastern Bass Strait). UL; Md, LL, T´ in scale = 0.5 mm; U3, Ep2, 3; T in scale = 1 mm.

Wilsons Promontory (39°12.9´S, 146°27.3´E), 65 m, NMV J52344 (5 males, 8 females, 2 juv.); NMV J52343 (1 male). 13.3 km E of eastern edge of Lake Tyers (37°51.74´S, 148°14.77´E), 37 m, NMV J25491 (1 female). 15.5 km SW of Pt Ricardo (37°53.14´S, 148°28.94´E), 45 m, NMV J25478 (4), NMV J25486 (1 male, 1 juv.), NMV J25485 (1 male, 1 female).

Diagnosis. Gnathopod 1 propodus and carpus relatively robust, propodus length in male twice of width; gnathopod 2 male palm distally next to palmar corner regularly J-shaped excavated, in female distally narrowing, with serrated palm. Pereopods 3–5 length subequal. Pereopod 7 basis ratio length : breadth= 1.5, posterior margin rounded. Uropod 3 very long, slim, rami about twice length of peduncle, always having a "knee" between peduncle and rami. Telson with short distal robust setae, distal one about one third to half of telson length.

Description. Adult male, female 7–9 mm.

Body slim, slender, fragile. Eyes reniform, medially narrowed, lower part longer and wider.

Antenna 1 half length of body, article 1 slightly shorter than article 2, accessory flagellum of 5 articles; antenna 2 gland cone long; peduncle reaches end of antenna peduncle article 2; flagellum of 11 articles.

Mandible incisor and lacinia mobilis with strong blunt teeth, accessory robust setae smooth; molar huge and oblong; palp article 2: article 1= 3.75, article 2 : article 3 = 1.8, article 2 with 9 single long setae (some plumose) without groups.

Gnathopod 1 coxa 1 anteriorly lengthened, rounded, basis ratio length : breadth= 2.8; merus posterodistally acutely pointed; carpus rounded, ratio length : breadth= 2; propodus palm oblique, scarcely defined.

Gnathopod 2 of *female* propodus ratio length : breadth = 2.6, palm nearly straight, with many shallow excavations about one

third of total length, corner not defined. Gnathopod 2 of *male* propodus rectangular, about twice as long as wide, palm in the shape of a question mark or J, well defined by a prominent acute tooth, next to it palm distally smoothly excavated, no serrations, proximally ending in a rounded hump, beset with many short robust setae.

Pereopods basis in female slender, in male robust, in pereopod 7 basis ratio length : breadth = 1.5, posterior margin rounded, only very small serrations.

Epimeral plate 1 shorter than epimeral plate 2; epimeral plates 1, 2 posterodistal corner with scarcely visible very shallow excavation and second tooth. Epimeral plate 3 with few but strong teeth distally.

Uropod 3 very characteristic, always having a "knee" between peduncle and rami; peduncle ratio length : breadth = 2.2, outer ramus ratio length : breadth = 6.75, with many robust setae marginally and distally in 8–9 groups, apically long setae, that are easily lost.

Telson with 1 strong short robust seta distally, less than half telson length, accompanied by 1 other, of half length, on each side; 1 plumose seta on the outer margin distally, 2 robust setae and 1 seta marginally.

Etymology. Dedicated to Kelly Merrin and Melissa Storey with whom I shared the lab at Museum Victoria and who at any time were helpful and friendly "daughters" to their guest!

Distribution. Bass Strait, Australia, muddy, medium to coarse sand, sand-shell, 33–65 m.

Linguimaera leo sp. nov.

Figures 10–12

Maera mastersi.—Barnard, 1972a: 226–227, fig. 132.
(not *Megamoera mastersii* Haswell, 1879b: 265, pl. 11 fig. 1)

Material examined. Holotype. Australia. Victoria, Port Phillip Bay, Prince George Light (38°6.3′S, 144°44.25′E), 9.6 m, silty sand with broken rock, SCUBA, Fisheries and Wildlife Dept and Museum, (stn PPS 10), NMV J35851 (1 male 12 mm).

Paratypes. Collected with holotype NMV J52309 (1 male, 2 juveniles, 11.8, 6-7 mm). Vic., Portland Bay, reef below lighthouse (38°22′S, 141°36.2′E), 3 m, sand and rubble, SCUBA airlift, R.S. Wilson, 26 Feb 1992 (stn CRUST 141); NMV J24121 (1 female, 15 mm). Western Port, off Crib Point (38°20.83′S, 145°13.49′E), 13 m, sandy gravel, Smith-McIntyre grab, A.J. Gilmour on FV *Melita*, 23 Mar 1965 (stn CPBS-N 32); NMV J48856 (more than 20 males, females).

Other material. Numerous specimens in 61 NMV collections from Vic. (Western Port, Port Phillip Bay, Cheviot Beach, Point Nepean, Bass Strait) and SA (Cape Northumberland, Wallaroo), 0–26 m, algal and sedimentary substrates. Port Phillip Bay (stn PPS 47 Area 40), USNM 275759 (1 male 12 mm, 1 female 10.5 mm, 2 male ?juvenile 10 mm); (stn PPS 83 Area 69), USNM 275759 (6 males 8–10.5 mm, 3 females, 7.5–8 mm).

Diagnosis. Gnathopod 1 propodus rectangular, ratio length : width = 2. Gnathopod 2 of male adult with prominent stout hump on palmar-corner, distally followed by a small incision; palm convex, with 3 incisions; dactylus near insertion not fitting totally to palm, leaving a hole-shaped gap. Pereopod 7 basis ratio length : width = 1.45. Telson with 1 long distal robust seta, between half and total telson length, and 3 short ones. (Pereopods 5–7 of ov. female strikingly twisted in articulation between merus and ischium.)

Description. Adult female 8–15 mm, male 7–12 mm.

Head nearly as long as first 2 segments, anteroventral corner acute. Eyes medially narrowed.

Antenna 1 about three fifths of body, peduncle article 1 subequal to article 2; flagellum of up to 30 articles, accessory flagellum of 3 or 4 articles; antenna 2 gland cone reaching half of article 3; flagellum of about 12 articles.

Mandible incisor, lacinia mobilis and molar medium; ratio palp article 2 : article 1 = 3; article 2: article 3= 1.8; palp article 2 densely setose with 5–6 groups. Maxilla 1 inner plate narrower than outer plate, oval, with 3 plumose robust setae; outer plate 6 simple to pectinate robust setae, about twice as long as large, palp article 1 quadrangular, article 2 twice as long as large, 8 robust setae only apically. Maxilla 2 outer and inner plates equal, robust setae only dis-tally, no fine hairs marginally. Maxilliped inner plate reaching one third of palp article 2, apically truncate with dense distal and a few lateral robust setae; outer plate large, oval, reaching two thirds of article 2 of palp, with curved robust setae, gradually increasing in length from inner to outer side; palp article 1 shorter than one third of article 2, article 3 half article 2, oval.

Gnathopod 1 not sexually dimorphic; coxa 1 anteriorly acutely lengthened; basis anterior margin with 4 or 5 medial robust setae, posteriorly longer robust setae; merus posteroventrally with short tooth; carpus regularly rounded on both margins, with stiff marginal and submarginal robust setae, about twice as long as wide; propodus rectangular, less broadened than carpus, ratio length : breadth = 2, palm oblique, well defined by blunt corner.

Gnathopod 2 of *female* strongly dimorphic in size, similar in shape; merus posterodistally with blunt tooth; carpus posteroventral corner with sharp tooth; carpus : propodus = 2:3, about same width; propodus rectangular, twice as long as wide, palm scarcely concave, scarcely defined by corner, no posterodistal "thumb"; 1 subdistal prominent robust seta on inner surface next to palmar corner, 6 smaller ones along palm. Gnathopod 2 of *male* strongly dimorphic in size and shape: the smaller is as described for smaller female gnathopod 2, the other has a palmar corner defined by a blunt and prominent "thumb", distally followed by a short excavation, palm with rounded hump having 3 short excavations; dactylus strongly curved, leaving a hole-shaped gap near insertion.

Pereopods 3, 4 shape very similar, pereopod 3 reaching distally about half of gnathopod 2 propodus. Pereopods 5–7 similar, very spinose, on both margins serrate, propodus equal to merus, carpus shorter, basis : propodus = 1.7; pereopod 5 basis posterior margin straight to concave and weakly serrate, posterodistal corner broadened and lengthened; pereopod 6 subequal or somewhat longer pereopod 7, posteroventral corner lengthened.

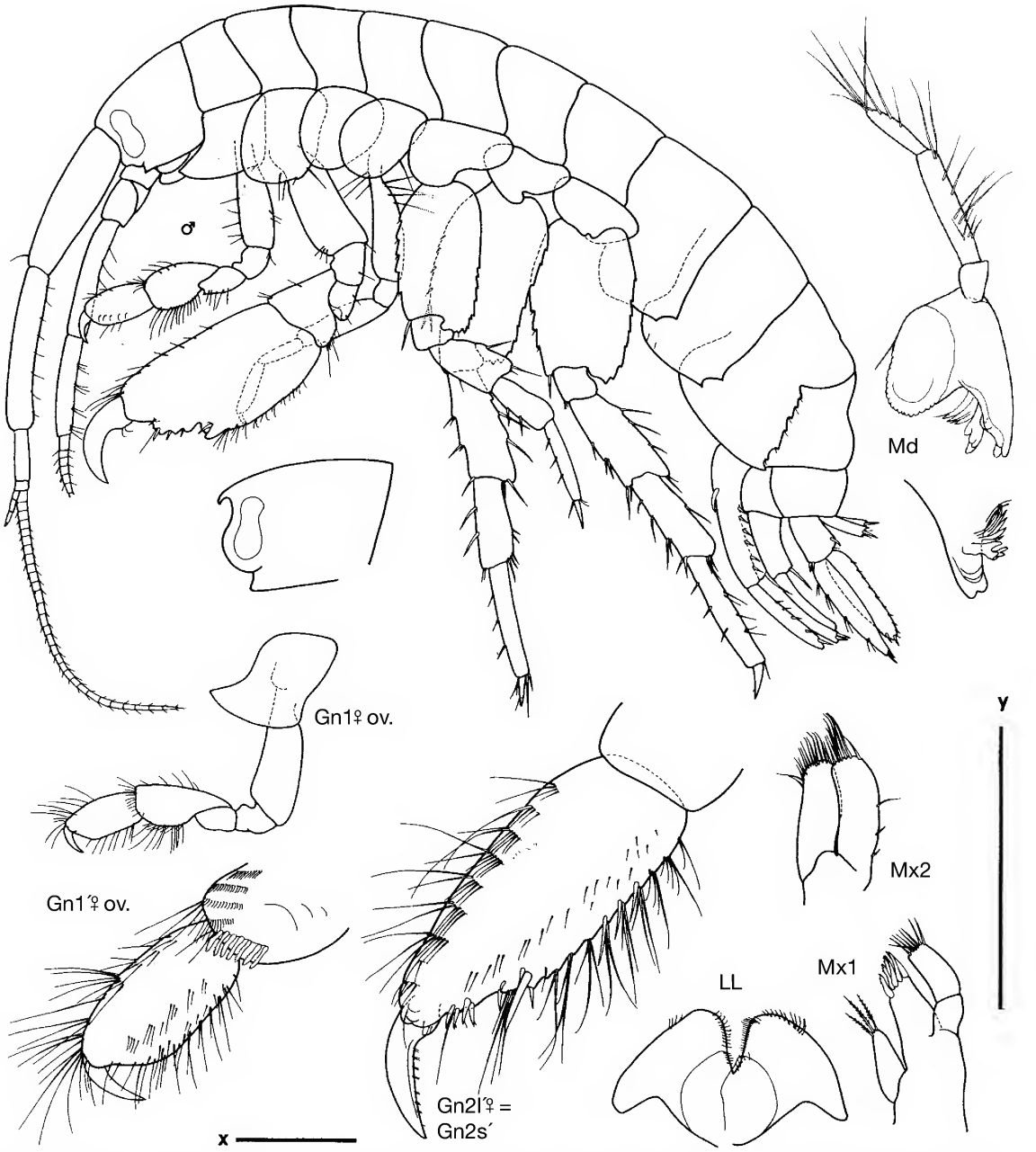

Figure 10. *Linguimaera leo* sp. nov., male, female (Victoria, Port Phillip Bay). Gn1 female in scale x = 1 mm, all other in scale y = 1 mm.

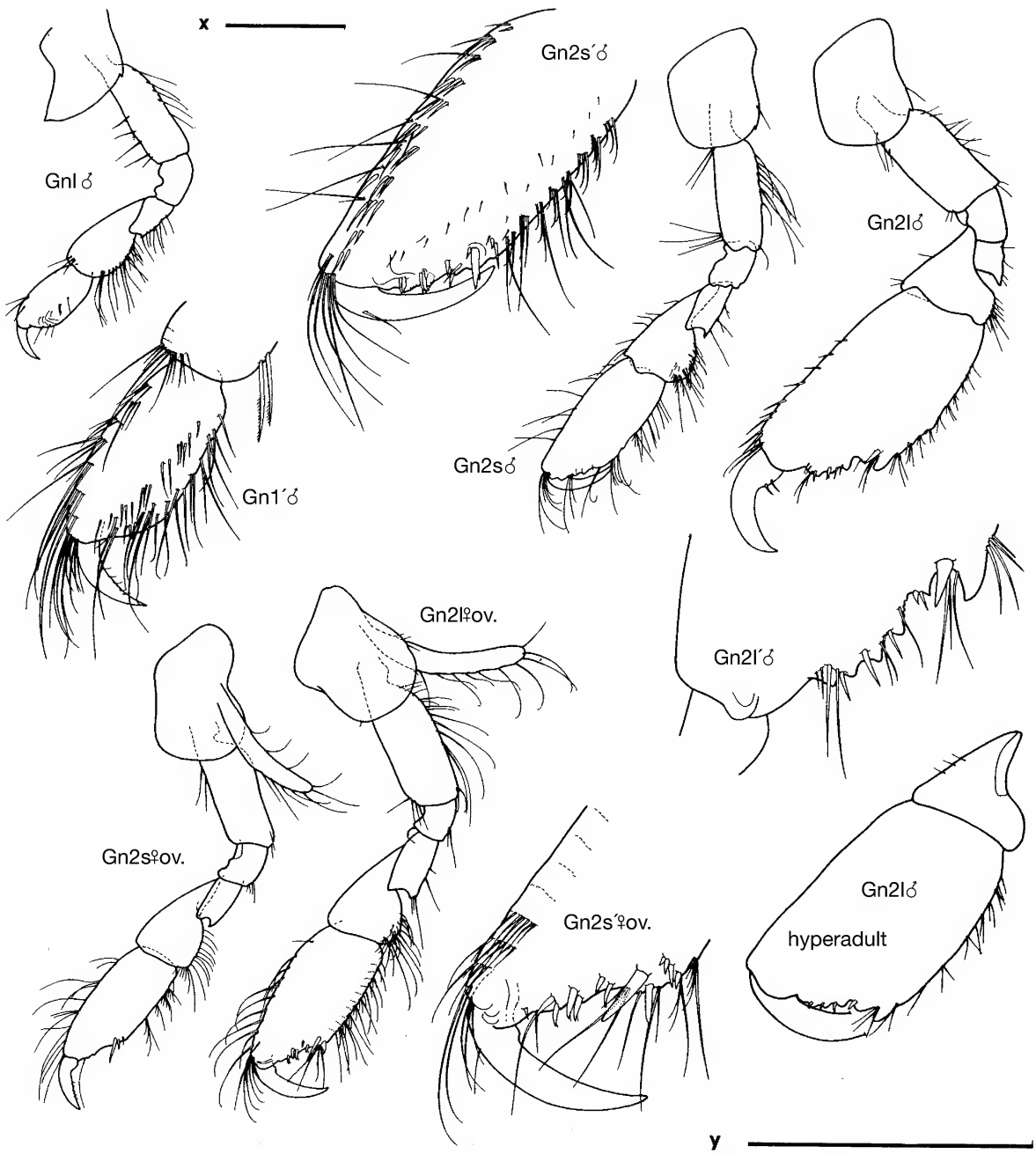

Figure 11. *Linguimaera leo* sp. nov., male, female (Victoria, Port Phillip Bay). Gn1 male, Gn2s male, Gn2 l large male, female, Gn2 male hyperadult, Gn2 small female in scale x = 1 mm; Gn1´ male, Gn2´ small male, Gn2´ large, Gn2´ small female in scale y = 1 mm.

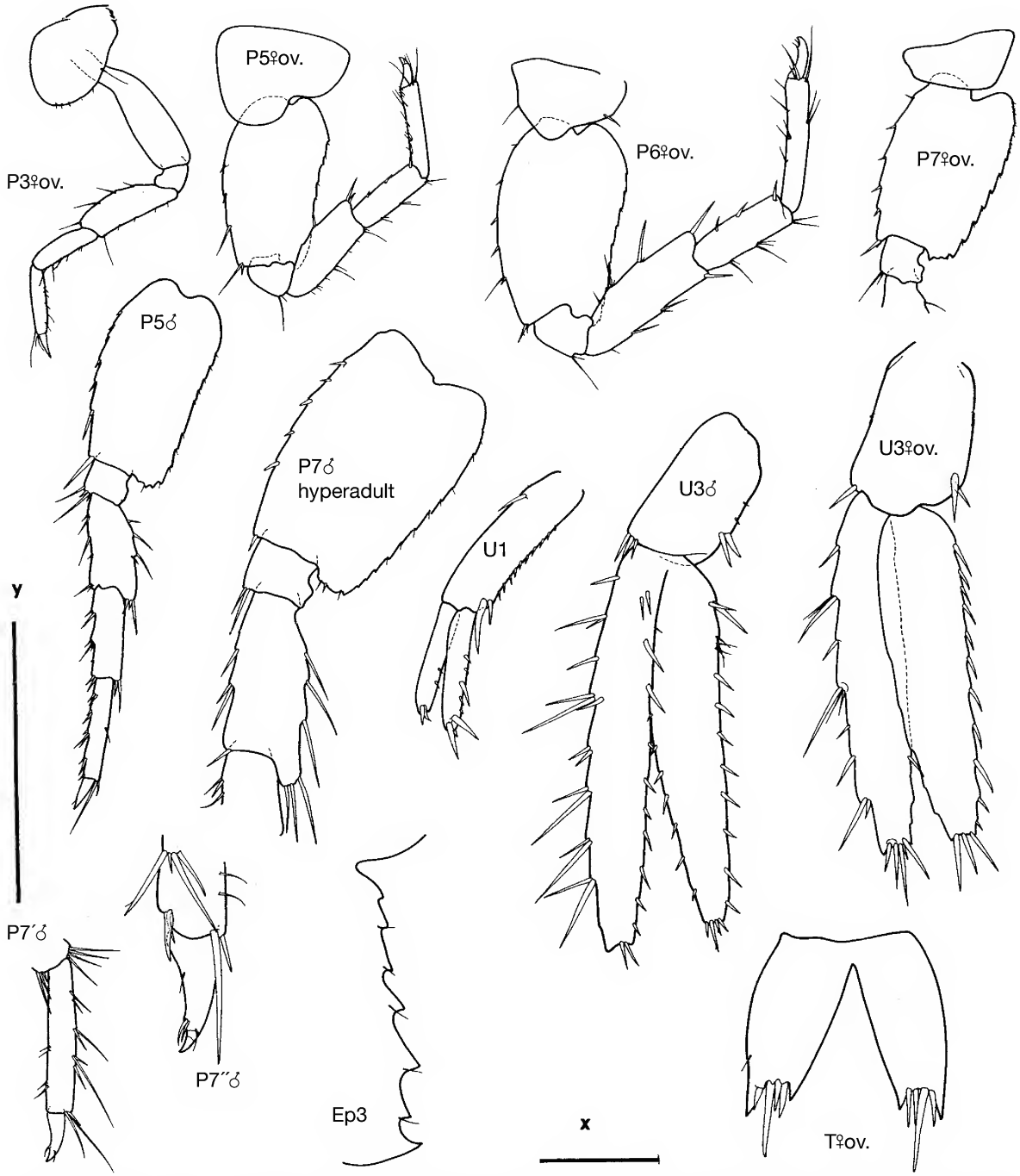

Figure 12. *Linguimaera leo* sp. nov., male, female (Victoria, Port Phillip Bay). P3–7 female, P7′, P7 hyperadult male, U1 in scale x = 1 mm; Ep3, U3 male, female, P7′′ male, T male, female in scale y = 1 mm.

Uropods 1, 2 ending at similar level; uropod 2 inner margin with 2 strong robust setae; uropod 3 peduncle half length of rami, outer ramus narrower than inner one; distally clearly truncate, with marginal robust setae on outer ramus in 7 or 8 groups.

Epimeral plate 3 serration with 7 or 8 teeth.

Telson quadrangular, 1 or 2 setae and no or 1 strong robust seta marginally; each lobe distally excavated as U-shape, with outer corner acutely prominent; in excavation 1 long robust seta (half or more telson-length) and 3 additional ones, not much surpassing length of the sinus.

Etymology. Dedicated to little Leo, the "most beautiful grandson in the world"! (noun in apposition).

Distribution. Victoria (Port Phillip Bay, Western Port, Portland Bay), South Australia (Wallaroo), Western Australia (Bunbury, Favourite Is, Point Peron) (J.L. Barnard, 1972a); littoral, gravel pools, under rocks and holdfasts on reef, sand and rubble, sandy gravel; occurred in 56 samples with depth average of 12 m; most robust adults in intertidal.

Remarks. Already Barnard (1972a: 226) noticed the somewhat "disproportionate" insertion between propodus and carpus of gnathopod 1, which leads to a deeper "gap" dorsally.

Discussion. This species is found sometimes together with *L. tias* sp. nov. and has for more than a century been mixed up with other similar species. The above cited bibliography therefore contains only the proven citation by Barnard (1972a). There are several records of "*M. mastersi* (Haswell)", mainly by Chevreux (1908: 481 – French Polynesia); Stebbing (1910: 457 – South Africa); Chilton (1916: 367 – New Zealand); Chilton (1925: 317 – Chatham Islands, New Zealand). But there is not enough information to make a conclusion.

Linguimaera aff. ***leo***

Material examined: Numerous specimens in 18 NMV collections from eastern and central Bass Strait, 13–60 m depth, and Western Port, Victoria; sandy sediments.

Remarks. There are robust specimens of 10–15 mm in the first 10 metres of Port Phillip Bay, with oblique to nearly transverse gnathopod 2 palm in male, and robust ovigerous females with characteristically upwards twisted pereopods. Below 10 m down to about 45 m or even 60 m, in coarse sands or sandy shells of southern and eastern Bass Strait, there is a population of smaller and more delicate specimens, adult males with well developed penis papillae never reaching more than 8 mm, and ovigerous females of 6–7 mm. Their legs (especially gnathopod 1 male , pereopods 5–7 basis) are more slender, the setation on gnathopods 1, 2 basis or uropod 3 is richer and some distal robust setae are very long. But pereopods are mostly missing, robust setae are easily broken or setae lost, and there is no obvious and clearly reliable morphological difference to offer at the moment, to allow defining it as a separate species, and all differences found may also occur in less adult specimens of *Linguimaera leo*. But I mistrust that *Linguimaera leo* could have such a wide depth range, and also the ecology is quite different.

Linguimaera mannarensis (Sivaprakasam)

Ceradocoides chiltoni.—Sivaprakasam, 1968a: 109–111, fig. 11 (not *Ceradocoides chiltoni* Nicholls, 1938).
Maera mannarensis Sivaprakasam, 1968b: 274–278, figs 1–2.
Maera mastersi.—Sivaprakasam, 1970: 36, fig. 1 a–g.
(not *Megamoera mastersii* Haswell, 1879a: 265, pl. 11, fig. 1).

Type locality. Gulf of Mannar, India.

Diagnosis. Gnathopod 1 propodus medially widened, 2.4 times longer than wide, palm oblique, straight; gnathopod 2 male strongly asymmetrical, larger propodus pyriform, with rectangular hump near dactylus insertion and deep U-shaped incision, defined by a sharp tooth; carpus triangular, shorter than broad; pereopod 7 basis rounded, posterior margin serrated, propodus posterior margin with 3 groups of long robust setae and a fourth posterodistally; uropod 3 rami twice as long as peduncle, apically truncate, richly beset with robust setae. Telson with long apical robust seta, length twice the depth of incision of lobes and more than one third of telson length, with 2 strong robust setae mediolaterally.

Description. Adults 8–9 mm.

Lateral cephalic lobes rounded, with notch, anteroventral corner rounded. Eyes inferior part a bit widened, medially not narrowed.

Antenna 1 about 0.6 of body length; peduncle as long as flagellum, peduncle article 1 shorter than article 2; flagellum of 26–29 articles, accessory flagellum of 4–5 articles; antenna 2 slender, gland cone short, peduncle article 4 shorter than article 5, flagellum longer than article 5, of 11 articles.

Mandibular palp article 1 longer than wide; ratio article 2 : article 3 = 1.2 (thus article 3 relatively long compared to other species); both with long setae, especially many dense on article 3 distally.

Gnathopod 1 sexual dimorphism not found. Coxa 1 anterodistally a bit upturned, bluntly pointed; basis ratio length : breadth = 3, posteriorly 5 long setae and some shorter ones; merus posteroventrally rounded (sharp tooth lacking here), twice as long as wide; carpus triangular, swollen; propodus slender, less broad than carpus, 3 times as long as wide, palmar corner scarcely defined.

Gnathopod 2 *male* strongly dimorphic, carpus in larger gnathopod short, shorter than broad; palmar corner well developed, with upturned point, followed by U-shaped incision defined by a straight blunt distal elevation of palm; no especially prominent robust seta except some submarginal along palm; dactylus strongly curved, the bend being stronger than the outline of propodus, thus inwards folded.

Pereopods 3, 4 very similar in shape and also size; pereopods 5, 6 robust, basis rectangular, small serrations on posterior margins, posterodistal corner slightly lengthened and not widened; pereopod 7 basis much larger, posterior margin rounded, serrated; robust setae on posterodistal corner of carpus reaching or surpassing half length of propodus.

Epimeral plate 3 with serration of 3 or 4 teeth.

Uropod 1 peduncle inferior margin subproximally with 1 strong robust seta, rami shorter than peduncle, outer a bit shorter; uropod 2 outer ramus as long as peduncle, inner a bit

longer; uropod 3 much longer than uropods 1 and 2, rami subequal, truncate, beset with many short robust setae of maximally one fifth ramus length.

Telson longer than wide, lobes outer end longer than inner one; in excavation 1 strong robust seta inserted (one third of telson length) without small additional ones. Outer margin medially and on proximal third, 1 other, shorter robust seta.

Distribution. Gulf of Mannar, India; seaweeds.

Discussion. I have not seen this species, thus the description relies on Sivaprakasam's papers. According to them, this species differs from all other species by the the inwardly-bent dactylus and cup-shaped short carpus on the larger male gnathopod 2, the widened and serrate basis of pereopod 7 with long, rich setation on other articles and a relatively long mandibular palp article 3.

Linguimaera tias sp. nov.

Figures 13–15

Maera mastersi.—Barnard, 1972b: 108–10, figs 55–56.—Sheard, 1936: 177–178 fig. 3.—Sheard, 1937: 24.

Maera mastersii.—Hale, 1929: 215, fig. 213.—Chilton, 1916: 367.—Chilton, 1925: 317.—Hurley, 1954: 603.—Lowry and Fenwick, 1983: 236.

?Moera mastersi.—Chilton, 1911: 564.—Chilton, 1921: 72–73.

(not *Megamoera mastersii* Haswell, 1879b: 265, pl. 1 fig. 1).

Material examined. Holotype. New Zealand, Otago Harbour, Shelly Beach, gravel pools, USNM 149478 (male 11.2 mm).

Paratype. Locality like above, USNM 149478 (ovigerous female 9.9 mm).

Other material. Numerous specimens in 39 NMV collections from Vic. (Western Port, Port Phillip Bay, Portland Bay), SA (Cape Northumberland), and eastern and central Bass Strait, 0–40 m depth, sedimentary and algal substrates.

Diagnosis. Gnathopod 1 propodus ratio length : breadth = 2.1–2.7, changing with age. Gnathopod 2 male, female propodus palm excavated, palmar corner in male without "thumb"-shaped prolongation; gnathopod 2 female similar in shape and not much different in size, slender. Pereopod 7 basis ratio length : breadth = 1.75. Telson with apical robust setae between half and total telson length.

Description. Adult male 10–17 mm, female 10–13 mm.

Eyes reniform, medially narrowed.

Antenna 1 0.8 of body length, peduncle article 1 shorter than article 2; flagellum of up to 46 articles, accessory flagellum of 6–7 articles. Antenna 2 gland cone nearly reaching end of article 3; peduncle reaches half of antenna 1 peduncle article 2; flagellum of 16–17 articles.

Mandible incisor and lacinia mobilis with strong blunt teeth, accessory robust setae serrate; molar huge and oblong; palp article 2: article 1 = 2.25, article 2 : article 3 = 1.3, article 2 with 12–13 long setae in 4–5 groups; maxilla 1 inner plate width subequal to outer plate; outer plate with 7–8 simple to pectinate robust setae; maxilla 2 setae only distal, but many fine hairs also marginally.

Gnathopod 1 weakly sexually dimorphic. Coxa 1 anteriorly bluntly lengthened; basis ratio length : breadth = 2.5; merus posteroventally bluntly lengthened; carpus regularly rounded on posterior margin, length about twice to 2.3 width; propodus palm oblique, scarcely defined.

Gnathopod 2 weakly sexually dimorphic, different in size, not in shape, subchelate.

Female slightly dimorphic in size, similar in shape. Coxa 2 quadrangular, merus posterodistally with sharp tooth; propodus palm concave with blunt hump medially, defined by a posterodistal tooth, a straight part distally and shallow excavation proximally; 1 subdistal prominent robust seta on inner surface next to palmar corner, 6 smaller ones along the palm. *Male* dimorphic in size and shape, but in hyperadults both gnathopods again similar in size and shape; when dimorphic, one is as described for female, the other has a stronger defined palmar corner, distally followed by deeper semicircular excavation, while straight distal half of female has 1 or more blunt humps medially; dactylus stout, curved.

Pereopod 3 not much shorter than gnathopod 2 in male; pereopods 3, 4 basis and merus strong, other articles slim. Pereopods 5, 6 basis : propodus = 1.5; pereopod 7 male ratio length : width = 1.7.

Uropod 3 marginal setae on outer ramus in 4 or 5 groups.

Telson distomarginally with 2 small additional setae, no robust seta; in the excavation of lobes, 1 robust seta of about half telson length and another of one third telson length.

Etymology. Dedicated to our newest family member and son-in-law Matthias, shortened to Tias (noun in apposition).

Discussion. This species is very similar to *Linguimaera mannarensis* (Sivaprakasam, 1968). Differences are: eyes oval, width medially narrowing (vs width not narrowing); lateral cephalic lobe anterodistal corner pointed and curved (vs very little developed, rounded); mandibular palp article 3 distally oblique (vs regularly rounded); gnathopod 1 propodus twice as long as wide (vs longer and narrower); gnathopod 2 carpus longer than wide (vs wider than long); pereopod 7 basis posterior margin only very weakly rounded (vs evenly excavate); telson subquadrate (vs longer than wide); marginally on first third no robust seta (vs. one stout robust seta).

Remarks. Thomson (1882: 235, fig. 4a) illustrated a New Zealand amphipod as *Moera quadrimana* with characters similar to the present species, although his fig. 4b probably deals with the true *Quadrimaera quadrimana* (Dana).

Distribution. New Zealand: Otago Harbour, Shelly Beach (Barnard, 1972b). Australia: Victoria: Port Phillip Bay, Western Port, Portland Bay, Cape Northumberland, Bass Strait. South Australia: Sellicks Beach (Sheard, 1936). Gravel pools, sand, silty clay; 3.5–40 m depth.

Linguimaera sp.

Figure 16

Material examined. South-western Bass Strait (39°32.8′S, 144°16′E), 18 m, 1 Nov 1980, fine sand, epibenthic sled, G.C.B. Poore on FV *Sarda* (stn BSS 107), NMV J 2505 (2 males 10 mm).

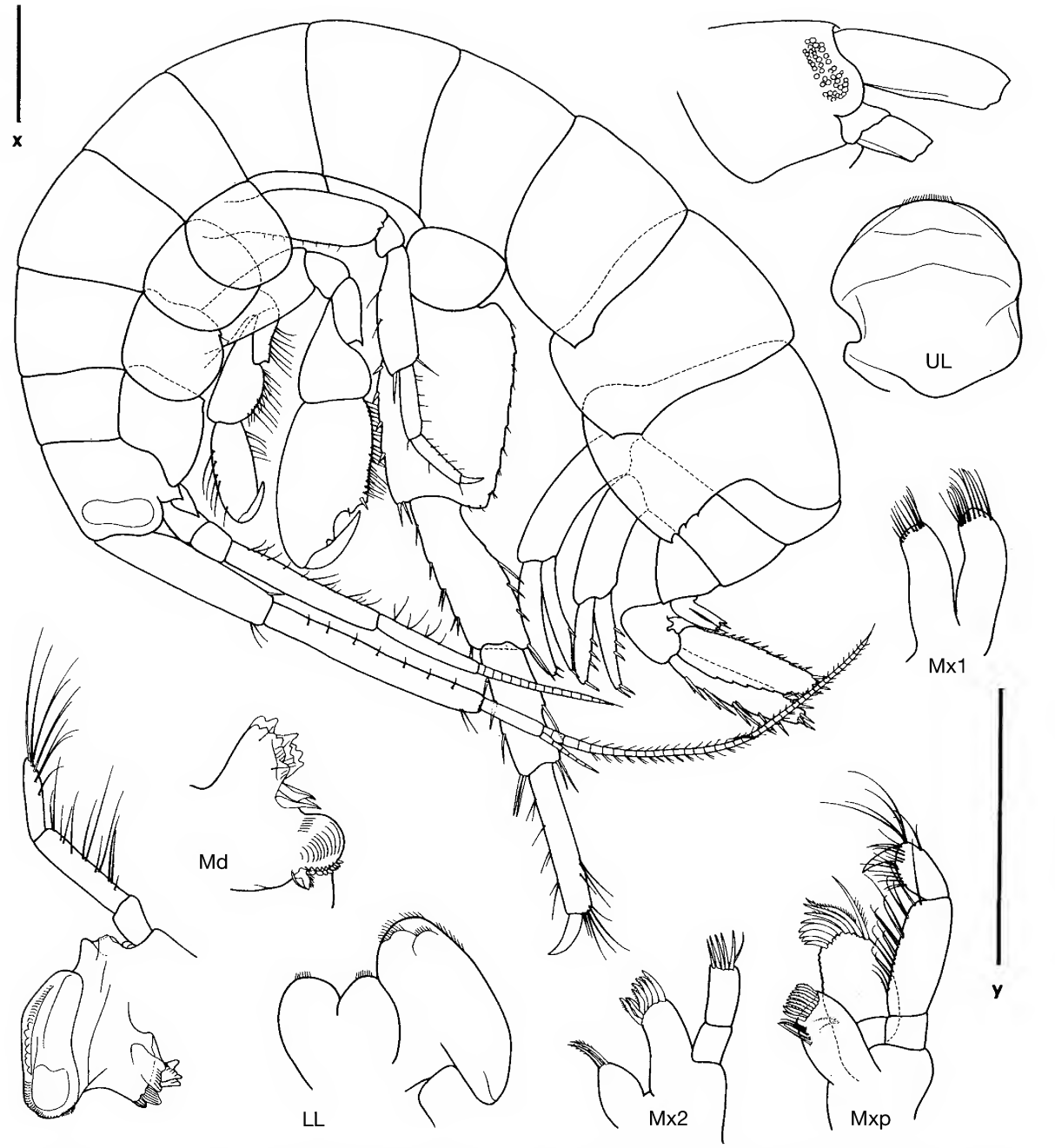

Figure 13. *Linguimaera tias* sp. nov., male (Victoria, Port Phillip Bay). Hd scale x = 1 mm; mouthparts UL; Mx1, 2; Md; Mxp; LL in scale y = 1 mm.

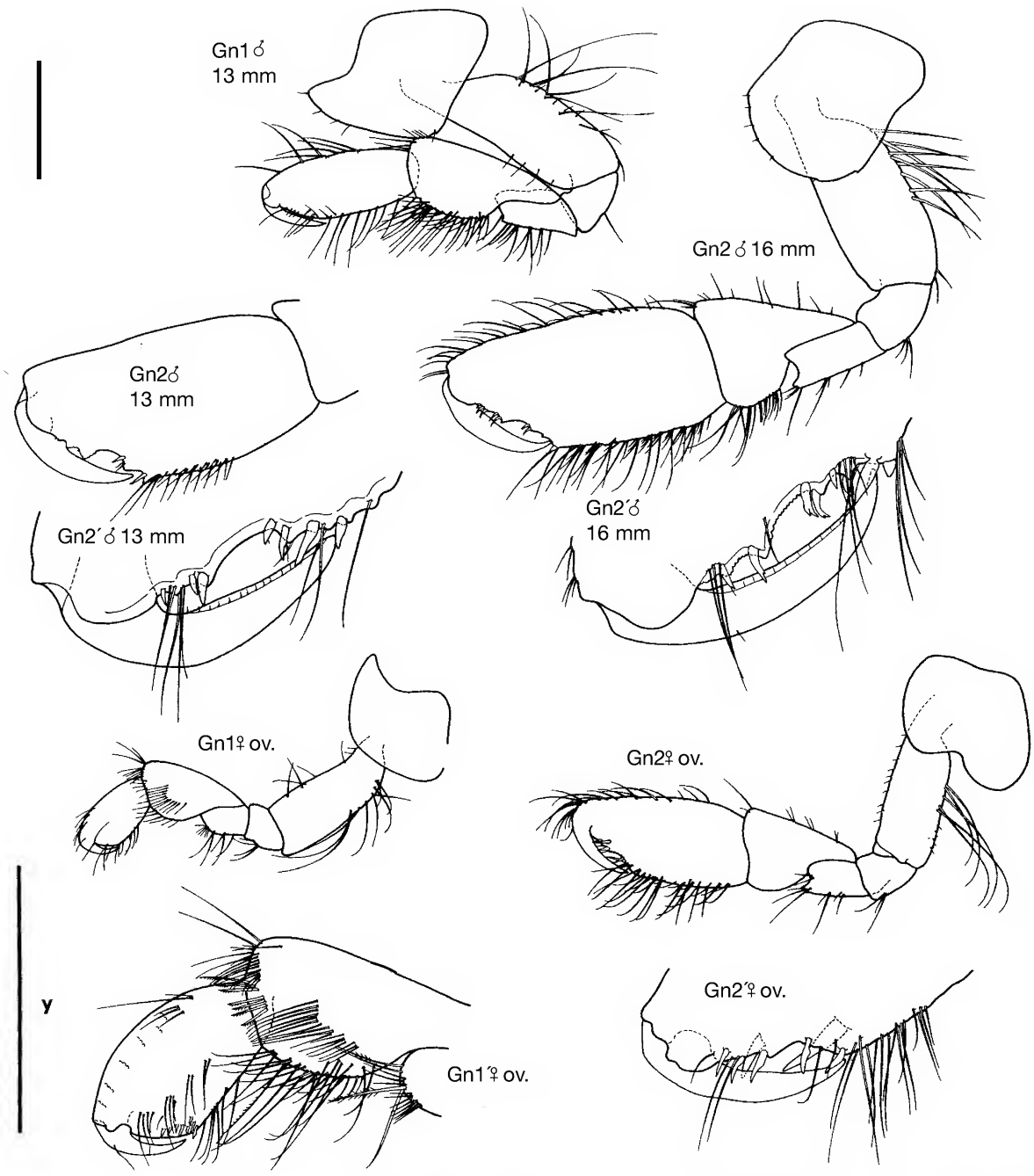

Figure 14. *Linguimaera tias* sp. nov., male, female (Victoria, Port Phillip Bay). Gn1, 2 male 13 mm, Gn2 male 16 mm, Gn1, 2 female in scale x = 1 mm; Gn2´ male 13 mm, Gn2´ male 16 mm, Gn1´ female, Gn2´ female in scale y = 1 mm.

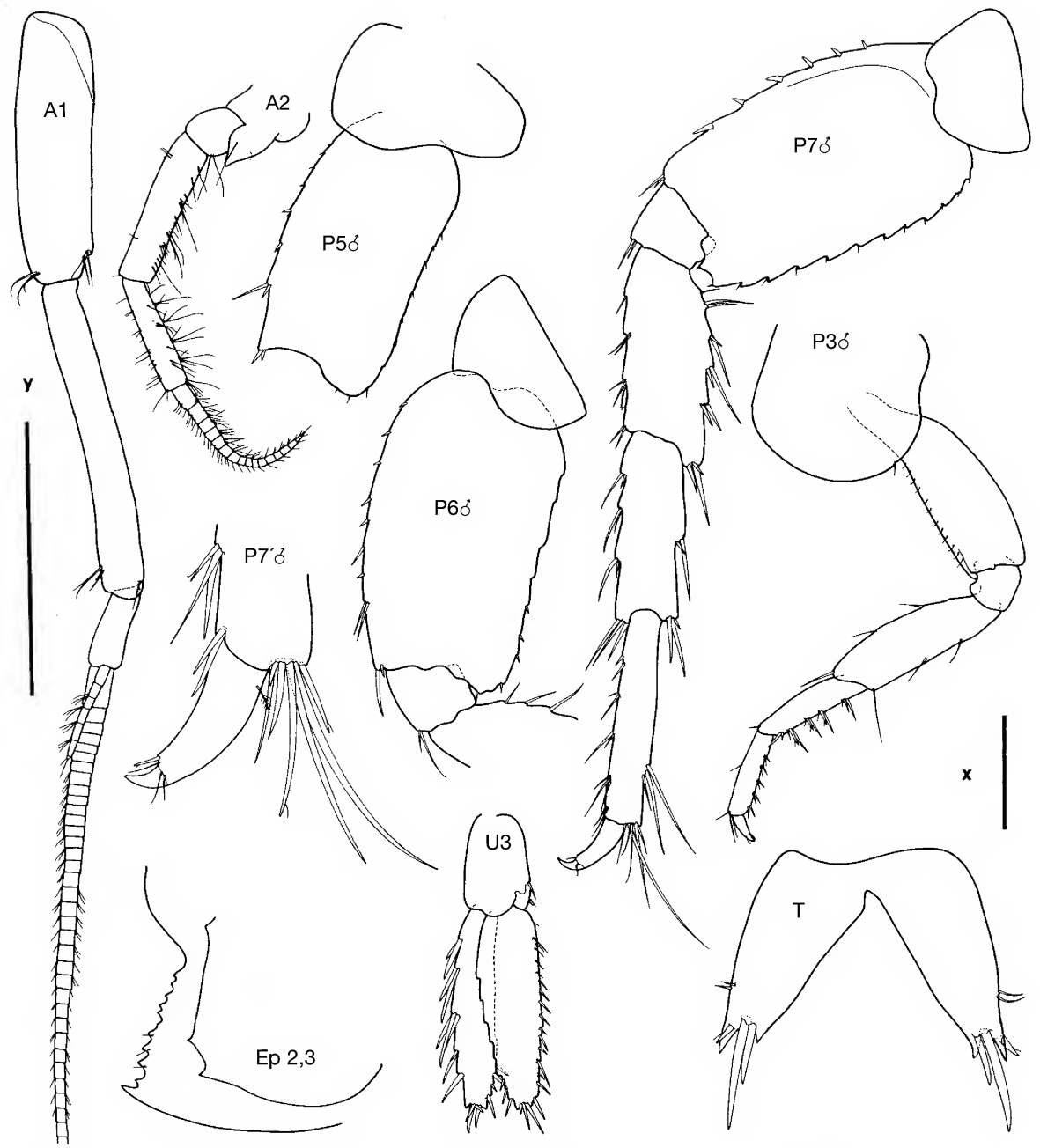

Figure 15. *Linguimaera tias* sp. nov., male, female (Victoria, Port Phillip Bay). P7´ male, T in scale y = 1 mm; all other in scale x = 1 mm.

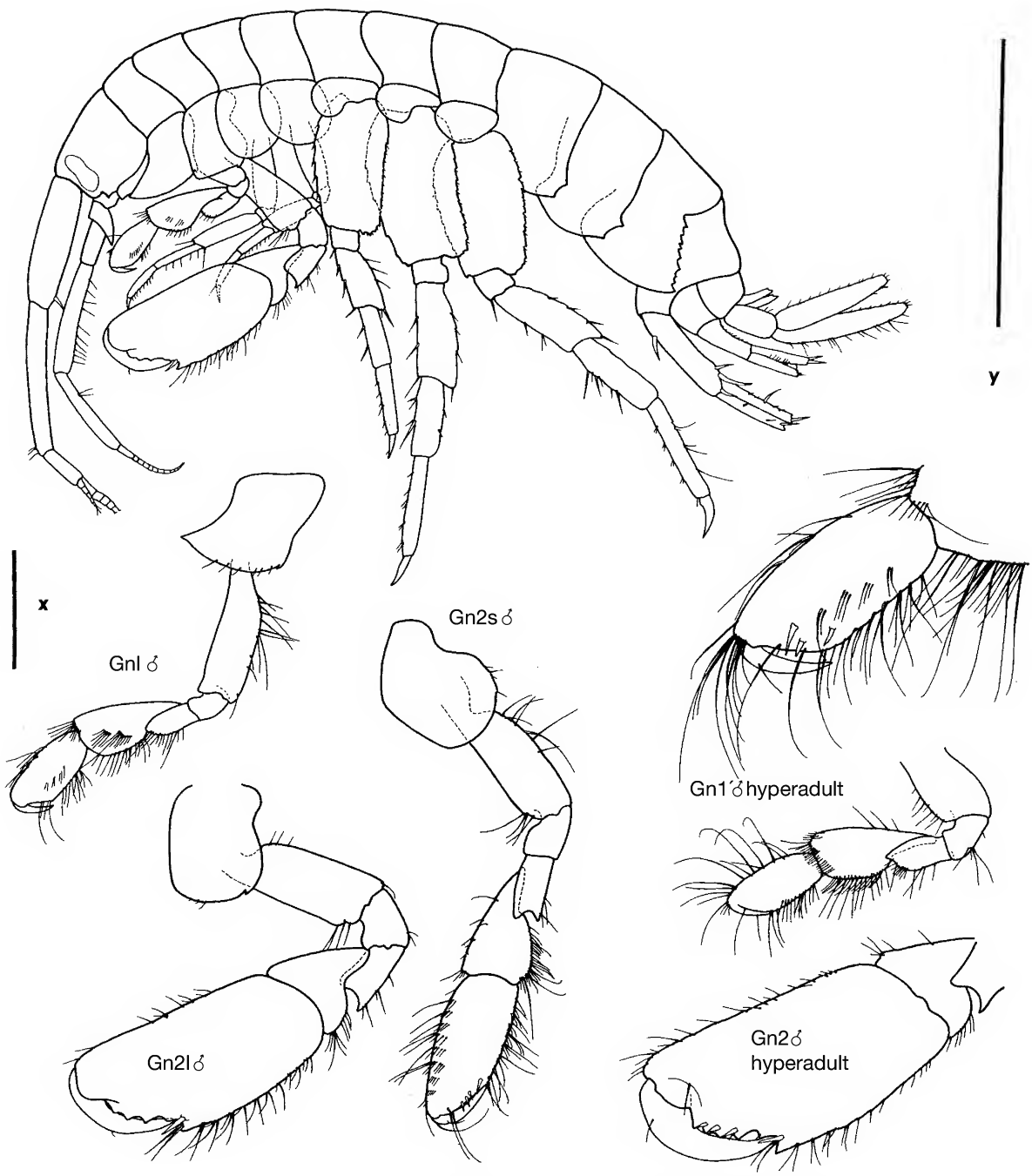

Figure 16. *Linguimaera* sp. (south-western Bass Strait). Gn1, 2 small male, Gn2 large male, Gn1, 2 hyperadult male in scale x = 1 mm; Gn1´ male hyperadult in scale y = 1 mm.

Diagnosis. Length 10 mm. Coxa 1 anteriorly acutely produced. Gnathopod 1 propodus slender, carpus much longer than propodus, widened. Gnathopod 2 male palm slightly excavated and crenulated. Pereopods 5, 6 basis rectangular, pereopod 7 posterodistal corner rounded, lengthened. Uropod 3 long, slim. Telson with short distal robust setae that are scarcely exceeding tip; 4 robust setae along inner margin of telsonic lobes.

Distribution. Bass strait.

Remarks. This material is very similar to *L. leo* sp. nov. and *L. tias* sp. nov. but the robust setae on the inner margin of telsonic lobes (naked in all other species) seem to be a good character to distinguish this species within the group. Not a large animal, in many respects these specimens seem more slender than *L. leo* : antenna 2 peduncle article 4, gnathopod 1 propodus and carpus, and gnathopod 2 dactylus, propodus are all narrower than in *L. leo*. *Linguimaera* sp. shares the narrow articles of appendages with *L. tias*, and also the rich setation on the posterior margin of the basis of gnathopods and the relatively long accessory flagellum, but again the spination of the telson is much different. Most probably these species have different ecological niches. The present material is too poor for defining a new species.

Megamoera thomsoni Miers, species dubia

Megamoera thomsoni Miers, 1884: 318, pl. 34, fig. B.

Remarks. Miers' description of his Australian *Megamoera thomsoni* could apply to a species of *Linguimaera* (especially the slim gnathopod 1, propodus without palmar corner, carpus very long would fit *L. pirloti*). But coxa 1 is definitely rounded anteriorly in Miers' species (vs very acute), the serrated excavation on gnathopod 2 palm could fit some of the described species, while the telson is figured very differently as densely beset with robust setae on the inner margin of the lobes, and apically without any incision. Thus, as the type material is apparently lost and the description short, *Megamoera thomsoni* Miers seems to be related to *Linguimaera* and may be even to *L. pirloti*, *kellissa*, young *L. leo* or the unnamed species, but should be considered as species dubia.

Maera aequimana Ledoyer, 1979, species dubia

Maera aequimana Ledoyer, 1979: 77–78, fig. 43.

Remarks. The figures of Ledoyer (1979) match well with species of *Linguimaera*. However, it is stressed that the second male gnathopods are not asymmetrical (therefore the name – it may be an immature specimen?) and we don't know the shape of the third uropods. In the slide of the holotype the telson is broken in pieces, so it is not clear how far it is cleft, while the remaining material in alcohol (1 male, 1 female, 1 immature) is not available. For the time being this species must remain dubious.

Conclusions

The genus *Linguimaera* has an Indo-Pacific distribution. It shows close relationship to *Zygomaera*, but the latter has an uncleft and more or less emarginate telson, while that of *Linguimaera* has a constant and quite characteristic structure in being deeply cleft with the tips of the lobes asymmetrically incised. The two genera share many other characters, such as the produced anterodistal corner of coxa 1, the thickened carpus of gnathopod 1, dimorphic gnathopods 2 in males (at least known in two species of *Zygomaera*), a shallow excavation on the posterodistal corner of epimeral plates 1 and 2, a serrate posterior margin of epimeral plate 3, and uropod 3 with a short peduncle and long rami with many short robust setae that are never longer than the rami. The differences with *Zygomaera* seem mainly to reside in the shape of the eyes (in *Zygomaera* rounded, often scarcely visible) and of the telson, but also in the always truncated tip of uropod 3 rami, which show in some species a minute second article. The last article of the mandibular palp is in *Zygomaera* (where known) only a little shorter or subequal to the second article (always clearly shorter in *Linguimaera*) and the falcate interramal robust seta distally on the peduncle uropod 1 is in *Zygomaera* strikingly strong and even on a special peduncle (vs less striking). While members of *Zygomaera* are not all described and known with all their crucial character states (and it might be that the emarginate telson is homoplastic), members of the new genus *Linguimaera* seem to form a natural group.

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Four new species of Ischnomesidae (Crustacea: Isopoda: Asellota) from off south-eastern Australia

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Abstract Merrin, K.L. and Poore, G.C.B. 2003. Four new species of Ischnomesidae (Crustacea: Isopoda: Asellota) from off south-eastern Australia. *Memoirs of Museum Victoria* 62(2): 285–307.

Four new species of Ischnomeidae Hansen, 1916 are described from the continental slope of south-eastern Australia: *Haplomesus franklinae, Ischnomesus tasmanensis, I. justi* and *Stylomesus sarsi*. The genera *Haplomesus* and *Stylomesus* are recorded from Australain waters for the first time. The family and three genera are rediagnosed to accommodate the new species.

Keywords Crustacea, Isopoda, Ischnomesidae, *Haplomesus, Ischnomesus, Stylomesus*, deep-sea, Australia

Introduction

The asellote isopod family Ischnomesidae is distributed throughout the world's deep oceans and continental slopes with 28% of the 94 described species known from the Southern Hemisphere. Little is known of its diversity in Australia and previous to this study only two species had been described from these waters. These, *Ischnomesus anacanthus* Wolff, 1962 and *Mixomesus pellucides* Wolff, 1962, were collected from the Tasman Sea during the voyage of the Danish research vessel *Galathea* during the early 1950s (Wolff, 1962). More recently, Poore et al. (1994) reported on the distribution patterns of a rich fauna of continental slope isopods from south-eastern Australia, western Tasman Sea and Bass Strait. These collections, made between 1979 and 1988, are part of Museum Victoria's SLOPE program. Among this abundant material were about 13 undescribed ischnomesid species. This paper describes four of these, now lodged at Museum Victoria, Melbourne (NMV) and supplementary specimens from the Australian Museum, Sydney (AM).

Due to their brittle nature, few specimens are intact and several individuals were illustrated to complete the sets of figures. The left side was dissected and drawn in preference, except when an appendage was damaged or missing. If both sexes were available, the most complete specimen was designated holotype and pleopods from the opposite sex were included in the description. Pereopod 1 is drawn figured for male and female as it is sexually dimorphic, being larger and more robust in females. Due to the rarity of material representing both sexes in ischnomesid samples, there is no consistency concerning the sex of the holotype in the literature.

Ischnomesidae Hansen

Ischnomesini Hansen, 1916: 54.—Wolff, 1956: 86.

Ischnomesidae.— Gurjanova, 1932: 40.—Menzies, 1962: 111.—Wolff, 1962: 71–73.—Birstein, 1971: 198–199.—Menzies and George, 1972: 971.— Chardy, 1974: 1537.—Kussakin, 1988: 418.

Diagnosis. Body elongate, subcylindrical and narrow. Pereonites 4–5 elongate, pereonite 5 longest, at least twice as long as wide, pereonite 4 widest anteriorly, 5 widest posteriorly. Head fused to and embedded in pereonite 1. Pereonites 1 (posterior margin) to 4 free and articulating. Pleon with maximum of 2 free pleonites plus pleotelson. Anus separated from branchial chamber. Eyes absent. Antenna 1 terminating with simple setae, article 1 squat and globular, article 2 elongate, at least twice as long as article 1. Antenna 2 length more than half body length, without squama. Maxilla 2 inferior margin with 2 medial pectinate setae. Pereopod 1 robust, strongly subchelate and haptorial; pereopods 2–7 ambulatory; dactylus with single unguis and 2 simple setae. Pleopod 3 endopod with 3 distal plumose setae, exopod tapering, shorter than endopod, with long distal plumose seta. Pleopod 4 unadorned, simple lobe, exopod absent; pleopod 5 absent. Uropod uniramous, terminal. In females, operculum wider at midpoint than proximally.

Remarks. This family is unique amongst the asellotes in having the fifth pereonite at least twice as long as wide and the head completely fused to the first pereonite, with only a slight

indentation between the somites, and medial pectinate setae on the inferior margin of maxilla 2. This paper acknowledges the often overlooked generic synonymies of Kussakin (1988).

Haplomesus Richardson

Haplomesus Richardson, 1908: 81.—Hansen, 1916: 59.—Gurjanova, 1932: 42.—Birstein, 1960: 6.—Menzies, 1962: 117.—Wolff, 1962: 86.—Birstein, 1963: 59.—Birstein, 1971: 209.—Menzies and George, 1972: 973.—Kussakin, 1988: 445.

Type species. Ischnosoma quadrispinosum Sars, 1879 (by monotypy).

Diagnosis. Pereonites 5–7 fused with pleonites; pleotelson fully fused to pereonite 7. Antenna 1 of 6 articles. Mandible palp absent. Maxilliped palp narrower than basal endite, articles 2 and 3 expanded. Pereopod 1 carpus of subequal width throughout length. Male pleopod 2 stylet does not extend beyond sympod. Uropod moderately short and of 1 article (except *Haplomesus franklinae* sp. nov.—with 2 articles).

Remarks. In his description of *Haplomesus*, Hansen (1916) stated that the uropods are of only one article. This is true of all except the new species described below which has two uropodal articles. In *Haplomesus franklinae*, the presence of biarticulate uropods is treated as a specific autapomorphic character. The fusion of pereonites 5–7 with the pleonites and pleotelson, and the stylet of male pleopod 2 not extending beyond the sympod, are two of the characters which preliminary phylogenetic analysis have shown to be key synapomorphies for this genus (unpubl. data). This analysis also shows that if *Haplomesus franklinae* were placed in another genus it would render *Haplomesus* paraphyletic.

Haplomesus franklinae sp. nov.

Figures 1–6

Material examined. Holotype. Australia, Vic., S of Point Hicks (38°25′S, 149°00′E), 1500 m, compacted clay, WHOI epibenthic sled, G.C.B. Poore et al., RV *Franklin*, 22 Jul 1986 (stn SLOPE 27), NMV J20300 (preparatory female, 6 mm).

Paratypes. Australia, Vic., 76 km S of Point Hicks (38°29.33′S, 149°19.98′E), 1840–1750 m, sandy mud, fine shell, WHOI epibenthic sled, G.C.B. Poore et al., RV *Franklin*, 26 Oct 1988 (stn SLOPE 69), NMV J20303 (1 male, 6 mm); same data as holotype, NMV J40686 (1 female, 6 mm).

Other material. NSW, 54 km ESE of Nowra (34°52.72′S, 151°15.04′E), 996–990 m, mud, fine sand, fine shell (stn SLOPE 53), NMV J20301 (1 female). Off Nowra (34°58.40′S, 151°23.20′E), 1750–1650 m, NMV J20305 (1 fragment). Off Nowra (34°51.28′S, 151°21.31′E), 1725–1701 m, (stn SLOPE 13), NMV J20304 (1 fragment). 40° 45′S 149° 09.3′E; 3000–2500 m (stn FR1086-4) Vic., 67 km S of Point Hicks (38°23.95′S, 149°17.02′E), 1277–1119 m, fine mud (stn SLOPE 67), NMV J20302 (2 females, 5 fragments). 76 km S of Point Hicks (38°29.33′S, 149°19.98′E), 1840–1750 m, sandy mud (stn SLOPE 69), NMV J40688 (2 males, 15 females, 41 fragments). S of Point Hicks (38°25′S, 149°0′E), 1500 m, compacted clay (stn SLOPE 27), NMV J40687 (2 females, 2 fragments).

Diagnosis. Body granulate, about 6 times as long as wide. Pereonite 1 with pair of long frontal-facing spines on anterolateral margin and pair of stout dorsal spines on posterior margin. Pereonites 2–4 each bearing pair of anterolateral spines, posterolateral margins of pereonites 5–7 rounded. Pereonites 4 and 5 about 2 and 7 times as long as pereonite 2 respectively. Pleotelson longer than broad, with wide dorsal keel. Antenna 1 of 6 articles, article 2 13 times as long as wide, 0.6 times as long as entire antenna 1, bearing 3 long flagellate setae and 1 aesthetasc. Antenna 2 article 3 more than twice as long as article 4. Mandible covered with microtrichs, molar elongate, with many small circular pits. Maxilliped palp articles 2 and 3 expanded, narrower than basal endite. Pereopod 1 carpus inferior margin with 1 simple seta, 2 long, robust flagellate setae and 1 long robust seta; propodus inferior margin with 2 short flagellate robust setae. At least pereopods 2–4 carpi with finely serrate distal margin. Pleopod 3 exopod with microtrichs, lateral margin with fringe of fine setae. Uropod of 2 articles, article 1 0.5 times length of article 2; article 2 with 1 brush seta.

Description of female holotype. Body length 6.3 times maximum width of pereonite 3 (excluding spines); cuticle calcified, brittle and granulated, all pereonites bearing numerous short simple setae. Head+pereonite 1 1.1 times as wide as long, with 2 anterolateral spines each as long as head+pereonite 1 and 2 short dorsal spines extending from medial ridge. Ratio of lengths of pereonite 2: pereonite 3 : pereonite 4 : pereonites 5+6+7+pleon (together), 1.0:1.1:1.9:12.1. Pereonite 2 slightly wider than pereonite 1, with transverse ridge. Pereonites 2–7 progressively decreasing in width posteriorly. Pereonites 2–4 each with pair of anterolateral spines. Anterolateral spines on pereonites 2 and 3 0.4 times as long as spines on pereonite 1; spines on pereonite 4 0.2 times as long as those on pereonite 1. Posterolareral margins on pereonites 5–7 rounded. Pereonites 5–7 and pleon with faint suture lines present at joins of these pereonites on dorsal surface, ventral surface fused completely. Pleotelson broad, dorsally with wide longitudinal ridge. Posterior margin rounded, swollen, with 2 medial subventral lobes.

Antenna 1 article 1 with 3 simple setae and 1 brush seta; article 2 4.0 times as long as and 0.2 times as wide as maximal width of article 1, with 8 simple setae of different lengths, 3 long flagellate setae, 1 brush seta and 1 distal aesthetasc; article 3 0.7 times as long as article 1, with 1 simple seta; article 4 0.6 times as long as article 1, with 3 simple setae and 1 brush seta; article 5 0.5 times as long as article 1, without setation; article 6 0.4 times length of article 1, with 5 distal simple setae. Antenna 2 article 1 quadrangular, without setae; article 2 approximately 0.6 times as long as longest margin of article 1, with no setae; article 3 elongate, about 4.3 times as long as article 1, with at least 11 simple setae; article 4 about 1.7 times as long as article 1, with 3 simple setae and few spinules on distal margin.

Mandible surface covered with microtrichs; incisor process with 5 cusps; lacinia mobilis with 2 cusps; spine row of 6 spines; molar long, rectangular, with numerous, small round pits, 9 fine simple setae on inferior margin and 5 fine simple setae on proximal margin. Maxilla 1 with both lobes bearing numerous microtrichs and fine simple setae on both margins; mesial lobe 0.9 times as wide as lateral lobe, with 1 dentate and 1 distal simple seta; lateral lobe with fine simple setae and microtrichs on surface and 12 distal, robust, dentate setae. Maxilla 2 lateral and middle lobes of equal width, lateral lobe with clusters of microtrichs on surface and 5 simple setae on inferior margin; lateral and middle lobes both with 4 distal pectinate setae of different lengths; mesial lobe 2.8 times as wide as lateral lobe, with many microtrichs and scale-setae covering surface, 2 long pectinate setae set medially on inferior margin, and distally, 4 dentate, 2 pectinate and 6 simple setae. Maxilliped coxa small, narrow, oblong; basis 1.8 times as long as widest point, with fine simple setae and 1 simple seta each on lateral

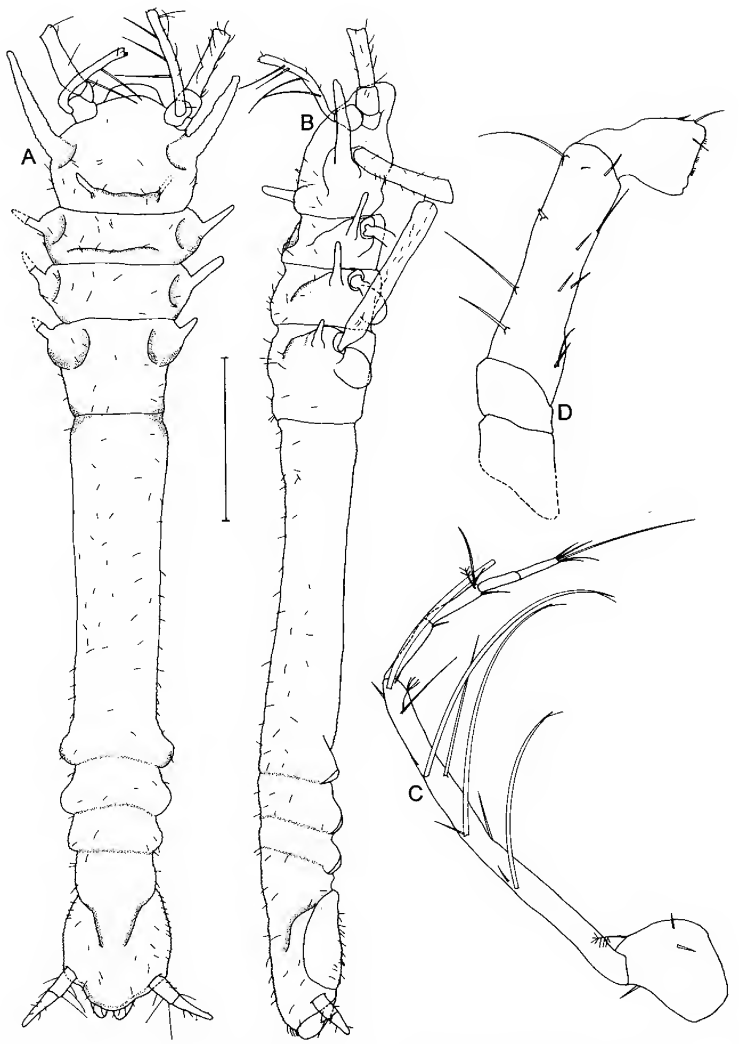

Figure 1. *Haplomesus franklinae* sp. nov., female holotype, NMV J20300: A, dorsal view; B, lateral view; C, antenna 1 (right); D, antenna 2. Scale bar = 1 mm, dorsal and lateral views only.

margin and surface, endite with 3 coupling hooks and distally 3 fan, 5 simple and many fine simple setae. Palp tapering, 2.6 times as long as basal endite; palp article 1 shortest, subrectangular, with few fine simple setae and 1 simple seta; article 2 0.6 times as wide as endite at maximum width, 2.1 times as long and 1.3 times as wide as article 1, with microtrichs on both margins, 2 simple setae and 1 small robust seta; article 3 width and length equal to that of article 2 surface and superior margin with microtrichs and 2 short setae and inferior margin with fringe of fine simple and 3 longer simple setae; article 4 much narrower than article 3, 1.6 times as long as article 1, with few microtrichs and 2 simple setae on distal margin; article 5 length equal to article 4 but narrower, bearing 5 simple setae and 1 thick distal seta. Epipod elongate, semicircular, length 3.5 times width and 1.1 times basis length.

Pereopod 1 basis 0.1 body length; ratio of lengths of articles, basis to dactylus, 1.0:0.4:0.2:0.4:0.3:0.3; basis with 12 scattered simple setae; ischium with 3 long and 2 short simple setae; merus with 1 long and 1 short seta on distal superior margin and 1 simple, 1 flagellate robust and 1 long robust seta on distal inferior margin; carpus width subequal, superior margin with 3 long, simple slender setae, inferior margin with 1 simple and 2 long flagellate robust setae on proximal half, and more distally with 1 robust seta; propodus width subequal throughout, superior margin with 3 long simple setae and 4 smaller simple setae, 1 simple seta set medially and inferior margin with 1 distal simple seta and 2 robust flagellate setae; dactylus with 4 simple setae on distal superior margin. Pereopods 2, 3 and 5–7 missing.

Pereopod 4 basis 0.2 body length; ratio of lengths of articles, basis to dactylus, 1.0:0.6:0.2:0.8: 0.5:0.2; basis with 22 scattered simple setae; ischium with 10 scattered simple setae; merus with 5 simple setae; carpus with 6 simple setae and 1 distal brush seta on superior

Figure 2. *Haplomesus franklinae* sp. nov., female holotype, NMV J20300: A, mandible; B, maxilla 1; C, maxilla 2; D, maxilliped (right).

margin, 2 simple setae set medially, 3 robust flagellate setae and distally, 1 long robust seta on inferior margin, distal margin finely serrate; propodus superior margin with 7 simple setae and 1 brush seta, inferior margin with at least 5 flagellate robust setae, 1 long robust seta and 1 simple seta; dactylus with 4 simple setae on superior margin.

Additional pereopods from female paratype. Pereopod 1 articles, length ratios same as in holotype; basis with 5 simple setae scattered; ischium with 3 simple setae; merus same as that of holotype, carpus width generally subequal throughout distally, widens slightly proximally, with 2 long and 1 short simple setae on superior margin, inferior margin setation same as holotype; propodus width subequal throughout, with 3 long simple setae and at least 1 smaller simple seta on superior margin, medially 2 simple setae and inferior margin with 2 robust flagellate setae; dactylus same as in holotype.

Pereopod 2 ratio of lengths of articles, basis to dactylus, 1.0:0.4:0.2:0.6:0.3:0.3; basis with 3 robust flagellate setae and 1 brush seta proximally, and 7 simple scattered setae; ischium with 4 simple setae; merus with 4 simple setae; carpus with 1 simple seta on superior margin and 1 on inferior margin, 2 robust flagellate setae and 1 long robust setae, distal margin finely serrate; propodus bearing 1 simple setae proximally, 1 short robust flagellate and 1 long robust seta on inferior margin and distally 3 simple setae, 1 brush seta and 1 robust flagellate setae and 1 long robust seta; dactylus with 4 short setae on superior margin.

Pereopod 3 ratio of lengths of articles, basis to dactylus, 1.0:0.6:0.1:0.8:0.5:0.3; basis bearing 3 proximal robust flagellate setae, 1 brush seta and 6 scattered simple setae; ischium with 4 simple setae; merus with 3 simple setae; carpus with 4 simple setae and 1 brush seta on superior margin, and inferior margin with 2 flagellate robust and 1 long distal robust setae, distal margin finely serrate; propodus with 1 simple seta on superior margin, inferior margin with 2 robust flagellate setae and 1 long robust setae with few fringed scales in between and distally with 1 robust flagellate, 1 brush and 2 simple setae; dactylus bearing 4 short setae on superior margin.

Figure 3. *Haplomesus franklinae* sp. nov., female holotype, NMV J20300: A, pereopod 1; female paratype, NMV 40686: B, pereopod 1 (right).

Pereopod 4 ratio of article lengths similar to that of holotype; basis bearing 13 simple and 2 brush setae; ischium with 7 simple setae; merus with 5 simple setae; carpus with 5 simple setae, 2 robust flagellate setae and 1 distal brush seta, distal margin finely serrate; propodus with 2 medial simple setae and on inferior margin 2 robust flagellate, 1 long and 1 short robust seta and 4 simple and 1 robust setae distally; dactylus same as in holotype.

Pereopods 5–7 missing.

Operculum length 0.9 times maximum width; numerous simple setae on both lateral margins and scattered on ventral surface, 9 long, plumose setae on posterior margin. Pleopod 3, exopod 0.8 times length of endopod, with few surface microtrichs and fringe of fine simple setae on superior margin. Pleopod 4 length 1.5 times width.

Uropod straight, 0.5 times length of pleotelson; article 1 short, with at least 5 simple setae; article 2 twice as long as article 1, tapering, with 3 simple setae and 1 brush seta.

Male. Pleopod 1 proximal end damaged; lateral margins indented, distal portion covered with microtrichs; medial keel extends distally with 4 simple setae on each side of suture line; distal margin with 5 simple setae on both left and right sides; prominent distolateral horns. Pleopod 2 sympod length 2.4 times maximum width; lateral margin curved with 7 simple setae and 6 distolateral plumose setae; exopod a small lobe, 0.2 times length of sympod; stylet 0.3 length of sympod, narrowing to a point; sperm duct 0.6 length of stylet. Pleopods 3 and 4 similar to female.

Distribution. South-eastern Australia, from Nowra, New South Wales, to Point Hicks, Victoria; 990–1840 m depth.

Etymology. For the CSIRO Research Vessel *Franklin*, from which the material was collected.

Remarks. Haplomesus franklinae is the fifth species of this genus to be described from the Southern Hemisphere, and the first to be described from Australian waters. In body form it most closely resembles *Haplomesus modestatenuis* Menzies and George, 1972, with both species having anterolateral spines on pereonites 1–4 and the posterior margin of the pleotelson with two medial subventral lobes. However, *H. franklinae* differs from *H. modestatenuis* in having stouter spines on pereonites 4 and 5, uropods with two articles that extend well past the pleotelson, lack of dorsal hooks on pereonite 7, and no robust setae on the posterolateral margins of the pleotelson (Menzies and George, 1972).

Ischnomesus Richardson

Ischnosoma Sars, 1868: 34 (preoccupied).

Ischnomesus Richardson, 1908: 81.—Hansen, 1916: 56.—Gurjanova, 1932: 40.—Wolff, 1956: 88.—Menzies, 1962: 111.—Wolff, 1962: 73.—Menzies and George, 1972: 971.—Kussakin, 1988: 419 (replacement name).

Rhabdomesus.—Richardson, 1908: 81.

Bactromesus.—Wolff, 1962: 83.

Type species. Ischnosoma bispinosum Sars, 1868 (by monotypy).

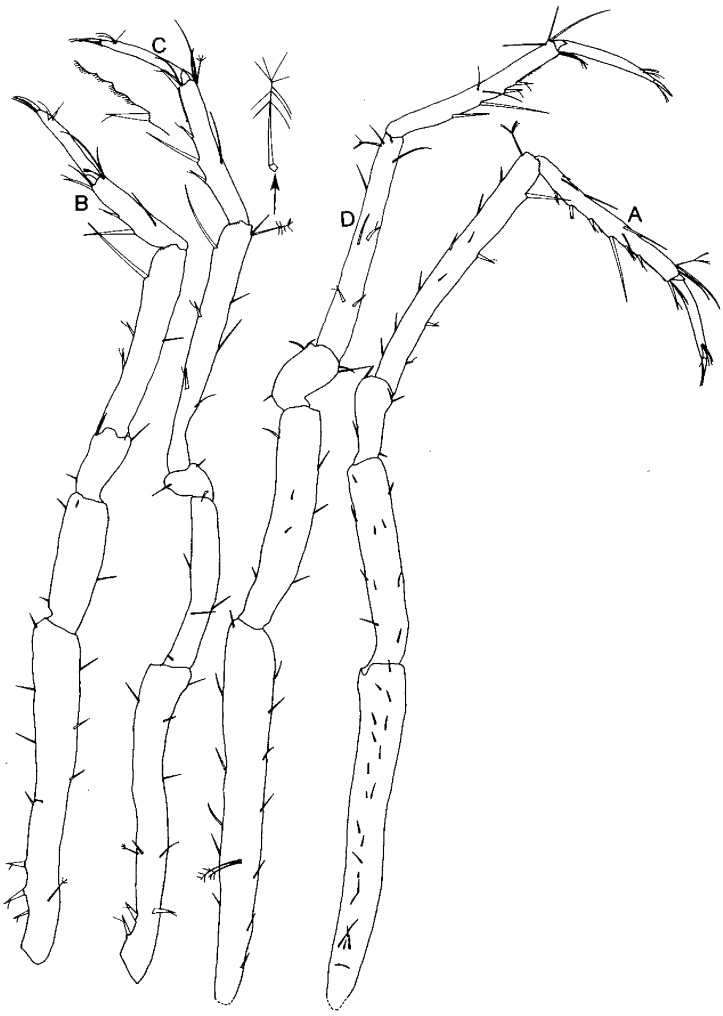

Figure 4. *Haplomesus franklinae* sp. nov., female holotype, NMV J20300: A, pereopod 4 (right); female paratype, NMV J40686: B, pereopod 2; C, pereopod 3 (twisted at merus); D, pereopod 4.

Diagnosis. Pereonites 5–7, pleonite 1 and pleotelson free and articulating. Remaining pleonites fused with pleotelson. Antenna 1 of at least 6 articles. Mandible palp usually absent. Maxilliped palp width at least equal with or wider than basal endite; articles 2 and 3 expanded. Carpus of pereopod 1 inferior margin usually expanded proximally. Stylet of male pleopod 2 either longer or shorter than sympod, if longer, can be whip like. Uropod long and of 2 articles (except *Ischnomesus justi* sp. nov.—with 1 article).

Remarks. The presence of a mandibular palp, the ancestral state in isopods, is confined to five species of *Ischnomesus* (namely *I. justi* sp. nov., *I. roseus* Wolff, 1962, *I. simplissimus* Menzies, 1962, *I. calcificus* Menzies and George, 1972 and *I. carolinae* Chardy, 1974), being absent in all other species in the family. The presence of a mandibular palp has never been considered as a character to remove these species from the family or even the genus *Ischnomesus*. A preliminary phylogenetic analysis placed those species with a palp within the '*Ischnomesus* clade' (unpubl. data).

In describing *Ischnomesus*, Hansen (1916) stated that the uropods are of two articles. In *Ischnomesus justi* the uropod is of one article. This character state has never been reported in this genus and, while such uropod characters are usually considered to be of generic significance (for example see Wolff, 1962), *I. justi* has free and articulating pereonites 5–7 and pleonite 1. This is the principal diagnostic of this genus. For further discussion, see *Remarks* under *I. justi* below.

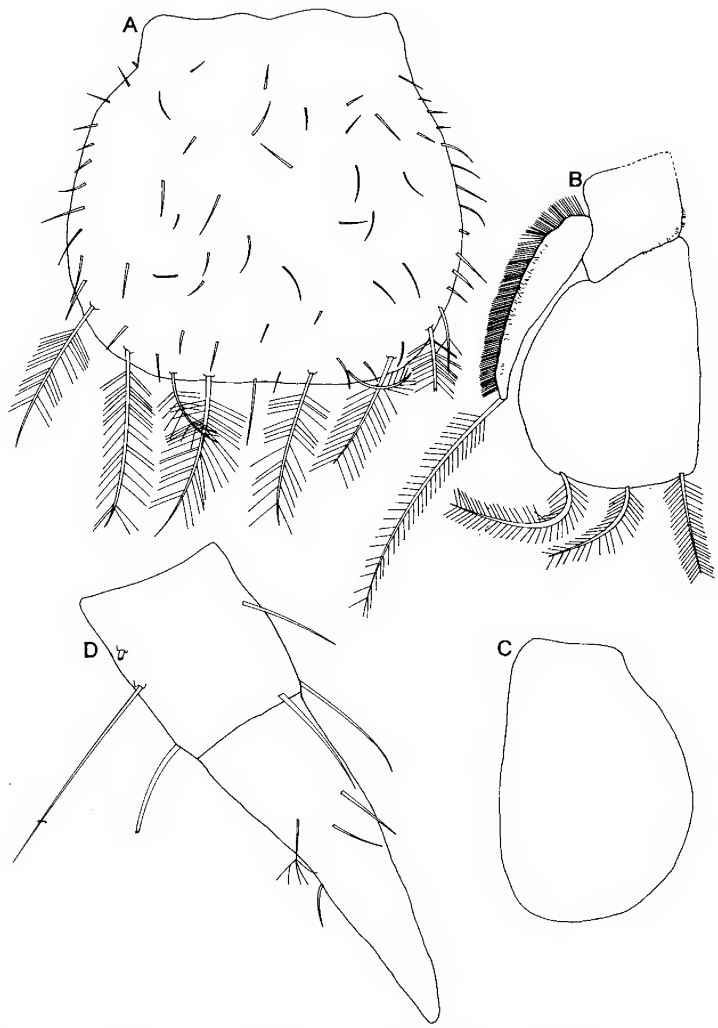

Figure 5. *Haplomesus franklinae* sp. nov., female holotype, NMV J20300: A, operculum; B, pleopod 3; C, pleopod 4; D, uropod.

Ischnomesus tasmanensis sp. nov.

Figures 7–11

Material examined. Holotype. Australia, Vic., 76 km S of Point Hicks (38°29.33′S, 149°19.98′E), 1840–1750 m, sandy mud, fine shell, WHOI epibenthic sled, G.C.B. Poore et al., RV *Franklin*, 26 Oct 1988 (stn SLOPE 69), NMV J20280 (immature male, 7 mm).

Paratypes. Australia, type locality, NMV J40684 (1 male, 7 mm; 1 female, 8 mm).

Other material. Australia, Vic., 67 km S of Point Hicks (38°23.95′S, 149°17.02′E), 1277–1119 m, fine mud, WHOI epibenthic sled, G.C.B. Poore et al., RV *Franklin*, 25 Oct 1988 (stn SLOPE 67), NMV J20279 (2 fragments). Type locality, NMV J40685 (4 fragments).

Diagnosis. Body covered in short setae, about 6 times as long as wide. Pereonite 1 with pair of 2 frontal-facing, long anterolateral spines and 2 stout dorsal spines. Pereonites 2–4 each with pair of stout dorsal spines; pereonites 2–4 each with pair of anterolateral spines; pereonites 5–7 each with pair of posterolateral spines. Pereonites 4 and 5, about 4 and 6 times the length of pereonite 2 respectively, pereonite 5 with 7 pairs of protrusions extending from each lateral margin, most terminating with long, thick simple setae. Pleotelson longer than broad, lateral margins with 3 large spines. Antenna 1 of 6 articles, with long simple setae present on articles 2 and 3. Antenna 2 article 1 fused to head, with 3 spines; articles 2–4 with numerous simple setae. Mandible without palp. Maxilliped palp article 2 widest; epipod with 3 simple setae. Pereopod 1 carpus with 2 long robust setae and several robust flagellate setae on inferior margin. Pleopod 3 exopod over half epipod length, superior margin with numerous fine simple setae and 9 simple setae.

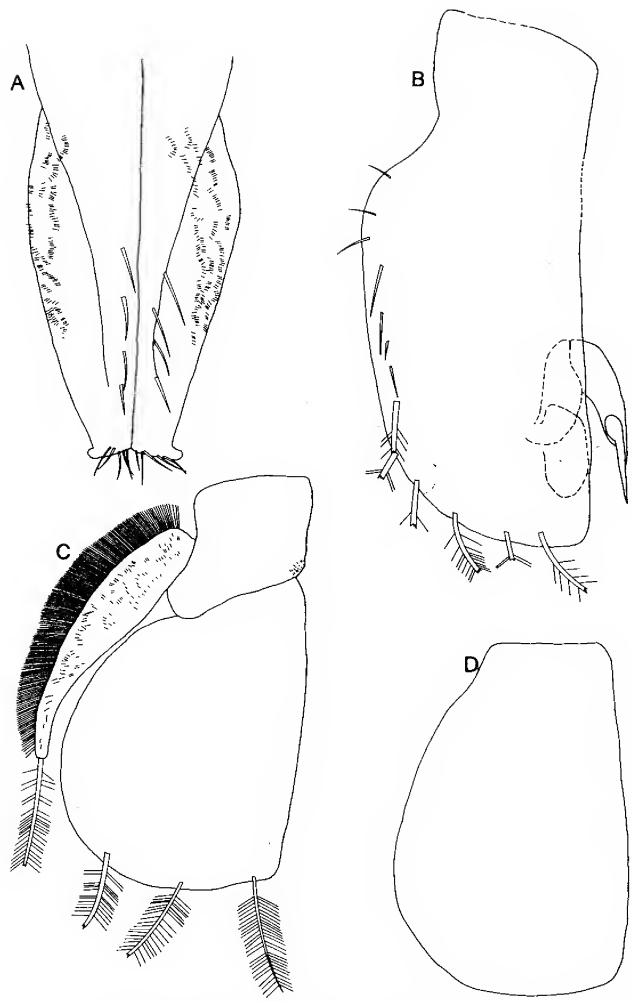

Figure 6. *Haplomesus franklinae* sp. nov., male paratype, NMV J20303: A, pleopod 1; B, pleopod 2 (right); C, pleopod 3 (right); D, pleopod 4 (right).

Uropod elongate, with article 2 1.4 length of article 1, both articles with many simple setae of different lengths, terminating with 3 long simple setae.

Description of immature male holotype. Body length 5.8 times maximum width of pereonite 3 (excluding spines). Body cuticle calcified and brittle, with numerous scattered simple long setae. Head+pereonite 1 length 0.8 times maximum width (excluding spines), with 2 long anterolateral spines that do not reach beyond front of head and 2 stout dorsal spines set posteriorly on pereonite. Although fused, head differentiated from pereonite 1, maximum width 0.7 times width of pereonite 1 (excluding spines), with pair of dorsal tubercles. Ratio of lengths of pereonites 2 : 3 : 4 : 5 : 6 : 7: pleonite 1 : pleotelson, 1.0:1.0:4.2:5.5:1.3:1.0:0.3:3.2. Pereonite 1 widest, pereonites 2–4 width subequal at widest point, pereonites 5–7 decreasing in width posteriorly Pereonites 2–4 with 2 anterolateral and 2 stout dorsal spines. Pereonites 5–7 with 2 posterolateral spines. Pereonite 5 with 7 pairs of long, thick, simple setae extending from small projections of cuticle. Pleotelson length 1.2 times width (excluding spines), elliptical, with 3 pairs of posterior-facing lateral spines extending from margin; posterior margin dorsal surface with small projection each side of median large projection; smaller projections are insertion point for uropod; ventral surface with triangular medial extension, not extending past margin.

Antenna 1 not complete, article 1 short, rectangular, distal end rounded, with 3 simple setae; article 2 elongate, 5.3 times as long as article 1, bearing 16 simple setae of different lengths and distally, 1 brush seta; article 3 2.9 times as long as article 1, with 12 simple setae of different lengths; article 4 1.0 times as long as article 1, with 1 simple seta and distally, 1 brush seta. Antenna 2 not complete, article 1 fused to head with 3 robust setae and 1 simple seta; article 2 with 11 simple setae; article 3 0.5 times as long as article 2, with 2 simple setae; article 4, damaged, portion present with 40 simple setae.

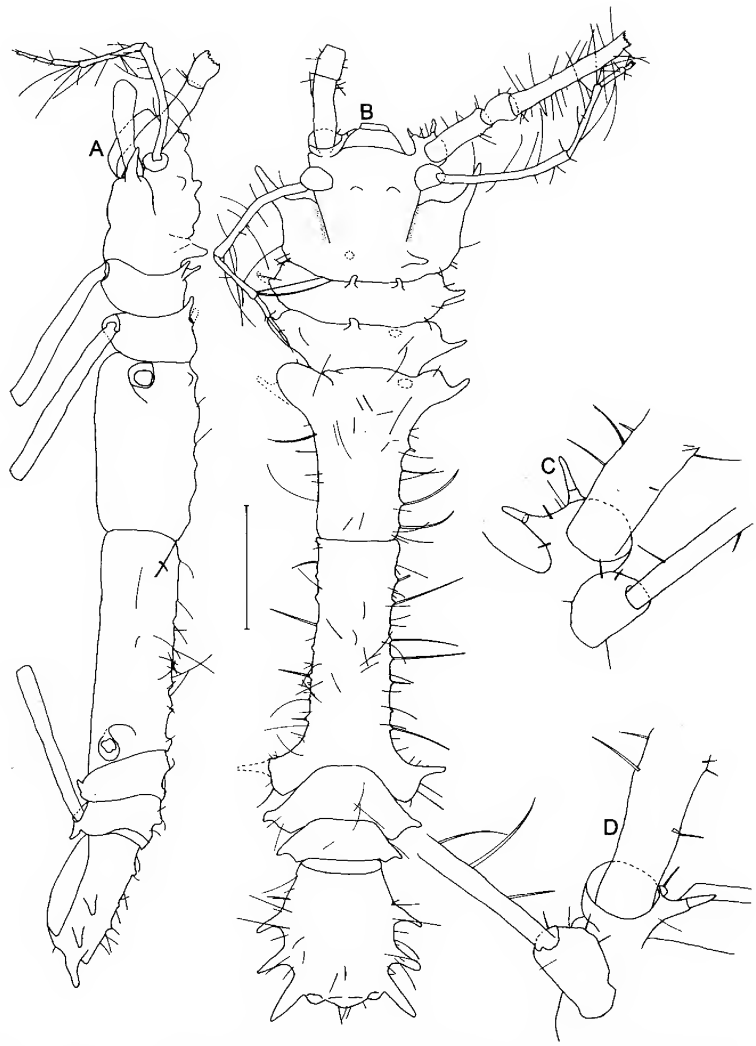

Figure 7. *Ischnomesus tasmanensis* sp. nov., male holotype, NMV J20280: A, lateral view; B, dorsal view; C, left antenna base; D, right antenna base. Scale bar = 1 mm, dorsal and lateral views only.

Mandible incisor process and lacinia mobilis each with 4 cusps; spine row of 7 spines; molar wide, rectangular, with row of 6 medial simple setae. Maxilla 1, both lobes with numerous fine simple setae on both margins; mesial lobe 0.7 times width of lateral lobe; with 1 short dentate and 7 simple distal setae; lateral lobe with 8 simple setae on distolateral margin, 12 distal, strong, dentate setae and few proximal microtrichs. Maxilla 2 lateral lobe 1.2 times width of middle, with many rows of microtrichs on superior margin and 6 simple setae on inferior margin; middle lobe with few microtrichs; both lateral and middle lobes with 4 long distal pectinate setae of different lengths; mesial lobe 2.4 times width of lateral lobe, with numerous fine simple setae and microtrichs on surface, 5 simple setae and 2 long pectinate setae medially set on inferior margin, and distally, 3 dentate setae, 2 long robust simple setae, 2 small pectinate and 11 simple setae of various lengths. Maxilliped coxa small, rectangular; basis length 2.1 as long as wide at widest point, endite with 3 coupling hooks, distally with 6 simple setae, 6 pectinate setae and 3 fan setae, flap with margin of fine simple setae. Palp narrowing, 3.2 times length of basal endite; article 1 squat and rectangular, with 1 simple setae on superior margin; article 2 1.4 times as wide as basal endite at maximum width, 1.6 times wider and 2.3 times as long as article 1, with 1 simple setae on superior and 4 simple setae inferior margin; article 3 width equal with article 2 at widest point, 2.0 times as long as article 1, with 1 simple seta on superior and 6 simple setae on inferior margin; article 4 1.7 times as long as article 1, much narrower than article 3, with 2 long simple setae on distal inferior margin; article 5 length equal to 4, with 2 simple setae and terminating with 2 robust simple setae; posterior face of palp, article 1 with 1 additional simple setae, article 2 with 2, article 3 with 2, article 4 with 2 and no additional setae on article 5. Epipod elongate, length 2.8 times width, 1.3 times basis length, with 3 long simple setae and microtrichs on superior margin.

Pereopod 1 basis 0.1 body length; ratio of lengths of articles, basis to

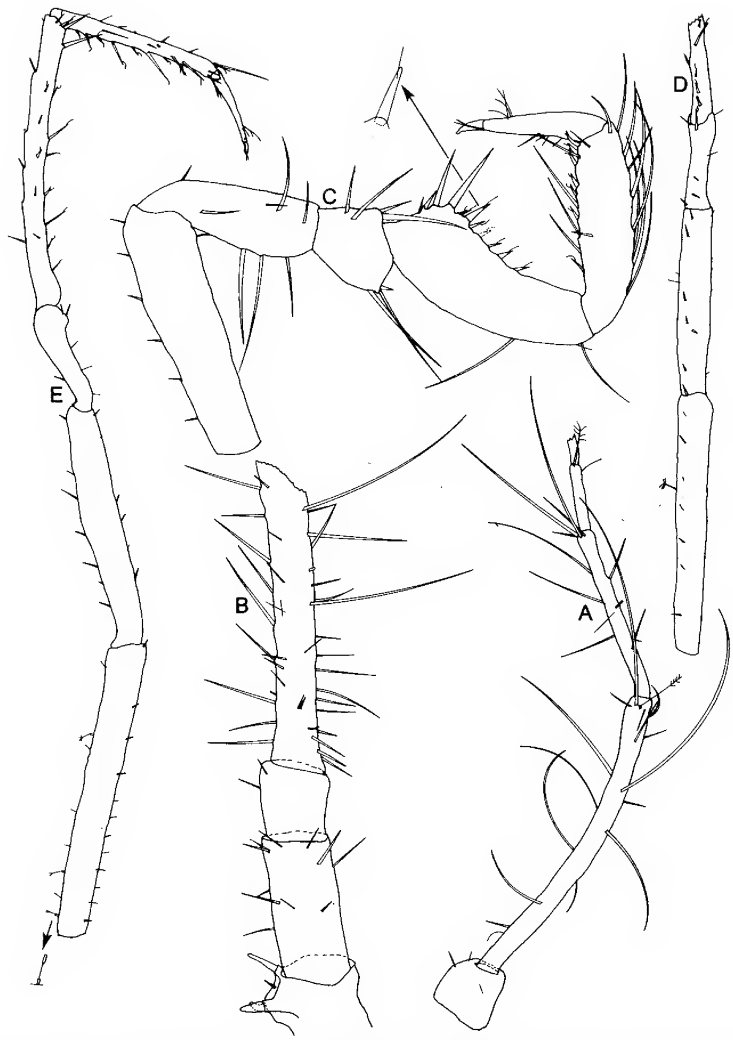

Figure 8. *Ischnomesus tasmanensis* sp. nov., male holotype, NMV J20280: A, antenna 1 (right); B antenna 2 (right); C, pereopod 1 (right); D, pereopod 2 (right); E, pereopod 3 (right).

dactylus, 1.0:0.7:0.3:0.8:0.7:0.4; basis with 7 simple setae, all except 1 on inferior margin; ischium with 8 simple setae of various lengths; merus with 2 long simple and 1 short robust setae on distal superior margin and 2 simple and 2 robust setae of different lengths on inferior margin; carpus wider proximally, superior margin with 2 long and 1 short simple setae and inferior margin with 1 short simple seta, 1 short and 2 long robust setae and 7 flagellate robust setae; propodus width subequal throughout, with 9 long simple setae on superior margin and inferior margin with 6 simple setae of different lengths interspersed between 7 flagellate robust setae; dactylus with 4 simple setae in inferior margin and clump of 4 simple setae on distal superior margin

Pereopod 2 basis 0.2 body length; ratio of lengths of articles, basis to merus (carpus–dactylus missing) same as in pereopod 1; basis with 7 simple setae and 1 medial brush seta; ischium with 11 simple setae; merus with 6 simple setae and 1 distal flagellate robust seta; part of carpus intact, with 1 simple seta and 5 robust flagellate setae.

Pereopod 3 basis 0.2 body length; ratio of lengths of articles, basis to dactylus, 1.0:0.8:0.4:1.0:0.5:0.3; basis with 17 simple setae, and superior margin also with 2 fork and 1 brush setae; ischium with 13 simple setae; merus with 6 simple setae; carpus with at least 8 simple setae and 13 flagellate robust setae, 3 of these on distal margin; propodus with at least 11 simple setae and inferior margin with 6 long and 5 short alternating flagellate robust setae on inferior margin; dactylus with 4 small simple setae on distal superior margin.

Pereopods 4–7 missing.

Pleopod 1 length 3.5 times proximal width; lateral margins each with 4 simple setae; ridge overlapping dorsal lobes at 0.9 length, with 6 simple setae on left and 7 on right; small distolateral horns extend from dorsal lobes. Penes triangular, 0.2 length of pleopod 1. Pleopod 2 sympod elongate, length 2.6 times maximum width, with 12 long, distal, simple setae; exopod short, roughly oval, length 0.2 times sympod length; stylet 0.8 length of sympod undeveloped. Pleopod 3 exopod 0.9

Figure 9. *Ischnomesus tasmanensis* sp. nov., male holotype, NMV J20280: A, mandible; B, maxilla 1; C, maxilla 2; D, maxilliped; E, basal endite of maxilliped, distal margin.

times endopod length with fine simple setae on both margins and 9 simple setae on superior margin. Pleopod 4 slightly elongate, length 1.8 times width.

Uropod (from male paratype) of 2 articles, elongate and slender; article 1 with at least 11 long simple setae; article 2 length 1.4 times article 1, narrower, with 21 simple setae and 3 long simple setae distally.

Female. Pereopod 1 thicker and more setose than in male; ratio of lengths of articles, basis to dactylus, 1.0:0.5:0.7:0.6:0.6:0.3; basis with 15 simple setae; ischium with 10 simple setae of different lengths; merus with 7 simple setae, 2 short robust setae and 2 long robust setae; carpus similar in shape but more robust than in male, with at least 6 simple setae on superior margin, inferior margin with 9 robust flagellate setae, 2 short robust setae, 2 long robust setae and at least 5 simple setae; propodus with 21 simple setae of different lengths on superior margin and 3 simple setae on surface, inferior margin with 11 robust flagellate setae and 4 long simple setae; dactylus similar to that in male although with 5 simple setae on inferior margin and clump of 3 on distal superior margin.

Distribution. South-eastern Australia, eastern Bass Strait; 1119–1840 m depth.

Etymology. For the Tasman Sea.

Remarks. This is the second species of *Ischnomesus* reported from the Tasman Sea off south-eastern Australia. The first, *I. anacanthas* Wolff, 1962, was described from only the anterior half of one specimen. The first four pereonites of *I. anacanthus* are totally devoid of both lateral and dorsal spines. Of other species, *I. tasmanensis* most resembles *I. birsteini* Wolff, 1962 (the anterior half of the type specimen was too damaged for an

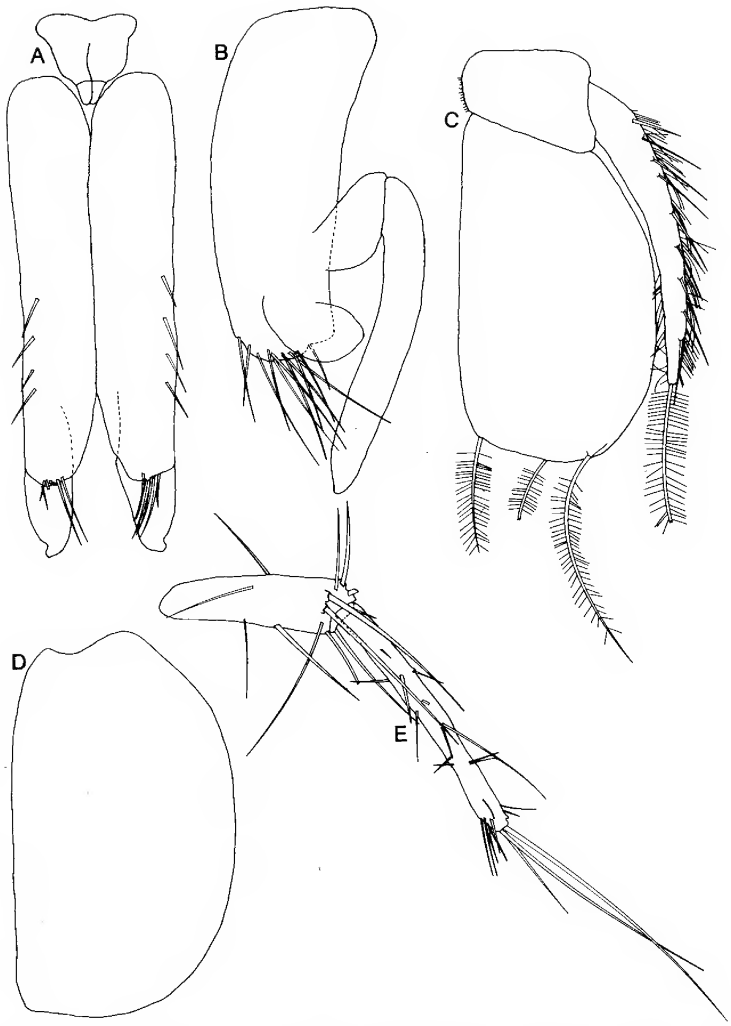

Figure 10. *Ischnomesus tasmanensis* sp. nov., male holotype, NMV J20280: A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 4. Male paratype, NMV J40684: E, uropod.

accurate description) and *I. spaercki* Wolff, 1956, both from the Kermadec Trench. All three species have long simple setae on lateral projections of the cuticle on pereonite 5, the pleotelson with posterior-facing lateral spines extending from margin and the second uropod article terminated with long simple setae. However, *Ischnomesus tasmanensis* can be distinguished from those two species by its pleotelson, which has three lateral spines on each margin and lacks spines on the dorsal surface. It can be further distinguished from *I. spaercki* by a pair of short dorsal spines on each of the first four pereonites as opposed to *I. spaercki* having a pair of dorsal spines on pereonite 1, 4 dorsal spines on pereonites 2 and 3, and short dorsal spines on pereonites 6 and 7.

Ischnomesus justi sp. nov.

Figures 12–14

Material examined. Holotype. Australia, NSW, 54 km ESE of Nowra (34°52.72′S, 151°15.04′E), 996–990 m, mud, fine sand, fine shell, WHOI epibenthic sled, G.C.B. Poore et al., RV *Franklin*, 22 Oct 1988 (stn SLOPE 53), NMV J20306 (female, 5 mm).

Paratype. Tasmania, eastern Bass Strait, 87 km ENE of North Point, Flinders I. (39°28.2′S, 148°52.4′E), 841 m, muddy sand, naturalists' dredge, G.C.B. Poore, HMAS *Kimbla*, 29 March 1979 (stn BSS 37), NMV J20309 (1 immature male, 5 mm).

Other material. Tasmania, 48 km ENE of Cape Tourville (42°00.25′S, 148°43.55′E), 1264–1130 m, gravel with lumps of sandy mud aggregate, WHOI epibenthic sled, G.C.B. Poore et al., RV *Franklin*, 30 Oct

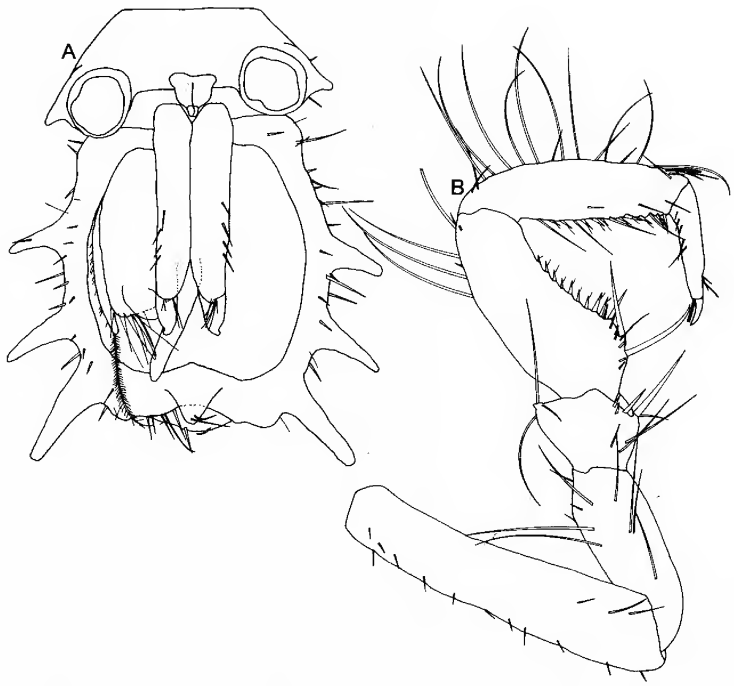

Figure 11. *Ischnomesus tasmanensis* sp. nov., male holotype, NMV J20280: A, pleotelson, ventral view. Female paratype, NMV J40684: B, pereopod 1.

1988 (stn SLOPE 81), NMV J20307 (1 male, 1 female). Eastern Bass Strait, 87 km ENE of North Point, Flinders I. (39°28.2′S, 148°52.4′E), 841 m, muddy sand, naturalists' dredge, G.C.B. Poore, HMAS *Kimbla*, 29 Mar 1979 (stn BSS 37), NMV J20308 (1 female). Paratype locality, NMV J40690 (1 fragment). Type locality, NMV J40689 (2 females, 1 fragment).

Diagnosis: Body smooth, about 6 times as long as wide. Pereonite 1 bearing pair of stout anterolateral spines. Pereonites 2–4 anterolateral margins and pereonites 5–7 posterior margin rounded, lacking spines. Pereonites 4 and 5 elongate, about 2 and 3 times length of pereonite 2 respectively. Pleotelson paddle-like, proximally with wide proximal keel. Antenna 1 with 6 articles, article 2 with several long flagellate setae. Antenna 2, article 1 not fused to head; articles 2 and 3 with 1 long robust seta on distolateral margin. Mandible with palp. Maxilliped palp article 2 widest; epipod broad, rounded, with no setae. Pereopod 1 carpus inferior margin with only long pectinate and simple setae. Pleopod 3 exopod small, length less than half of endopod. Uropod of single article, inserted at about 90° in pleotelson with 4 simple setae.

Description of female holotype. Body length 5.8 times maximum width of pereonite 3. Body cuticle smooth, calcified and brittle, with few short simple setae scattered over pereonites. Head+pereonite 1 curved around in lateral view, with 2 short anterolateral spines. Ratio of lengths of pereonites 2 : 3 : 4 : 5 : 6 : 7 : pleonite 1 : pleotelson, 1.0:1.3:2.2:2.9:0.9:0.8:0.3:1.6. Widths of pereonites 1 (including spines) to 3 equal; pereonites 4–7 widths decreasing (at widest part) posteriorly. Pleotelson long, paddle-like in dorsal view, length 1.3 times widest point; apex broadly rounded, with angular posterolateral corners.

Antenna 1 article 1 conical, bearing 1 short simple seta and 1 distal brush seta; article 2 elongate, 4.4 times as long as article 1, with 6 simple setae, 4 long flagellate setae and 1 brush seta; article 3 1.8 times length of article 1, with 2 distal simple setae; article 4 0.6 times length of article 1, with 3 simple setae; article 5 0.8 times length of article 1, with 1 simple seta; article 6 length equal to article 5, with 2 short simple setae and 4 simple setae of different lengths distally. Antenna 2 not complete; article 1 broad and short, with 1 simple seta; article 2 with longer lateral margin, 1.4 times length of article 1, with 1 simple seta and 1 distal lateral robust simple seta; article 3 elongate, 2.1 times length of article 1, with 2 simple setae and 1 distal lateral long robust seta; article 4 quadrangular, 1.5 times length of article 1, with 3 simple setae.

Mandible body with 1 simple seta near palp; incisor process with 5 cusps; lacinia mobilis with 4 cusps; spine row of 5 spines; molar rectangular, angled tightly towards spine row, with microtrichs and cusp on proximal margin; palp article 1 with 1 simple seta; article 2 1.7 times as long as article 1 with many microtrichs and 2 pectinate setae on inferior distal margin; article 3 0.5 times as long as article 1 with microtrichs on the inferior margin and terminating with 1 pectinate seta. Maxilla 1 with mesial lobe 0.6 times width of lateral lobe, with numerous fine simple setae on superior margin, and distally 2 simple setae, 1 pectinate seta and 1 dentate seta; lateral lobe with many fine simple setae on face and superior margin, distally 2 simple and 12 strong, dentate setae. Maxilla 2 lateral lobe wider than middle, with a few fine simple setae, 19 simple setae and distally, 1 long pectinate and 3 long simple setae; middle lobe 0.8 times width of lateral lobe, with 2 simple setae on inferior margin and distally, 1 long pectinate and 2 long

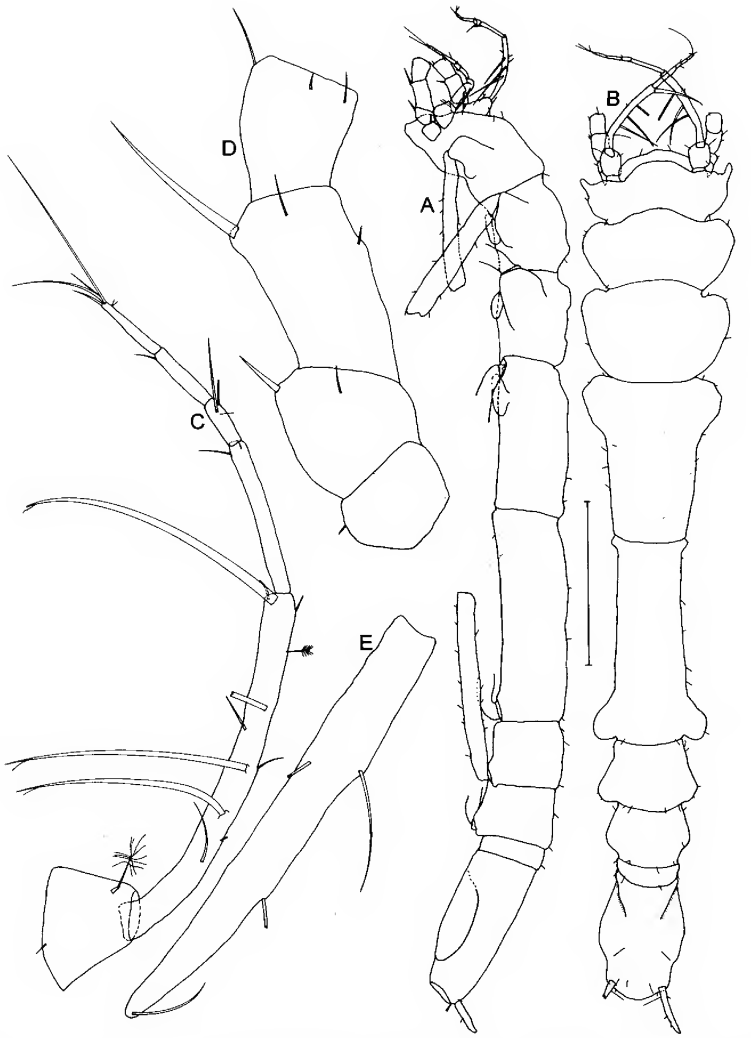

Figure 12. *Ischnomesus justi* sp. nov., female holotype, NMV J20306: A, lateral view; B dorsal view; C, antenna 1; D, antenna 2; E, uropod (right). Scale bar = 1 mm, dorsal and lateral views only.

simple setae; mesial lobe 2.0 times as wide as lateral lobe with many fine simple setae covering face, inferior margin with 7 simple setae, medially 2 long pectinate setae, and distally 3 small pectinate, 1 dentate and 13 simple setae. Maxilliped coxa large, rectangular; basis 1.7 times as long as widest point, curved over on inferior margin with fringe of fine simple setae, 2 simple setae and endite with 3 coupling hooks, and distally 3 fan and 7 simple setae. Palp tapering, 2.6 times length of basal endite; palp article 1 shortest, wide, rectangular, bearing 4 simple setae; article 2 wide, triangular, 0.9 times maximum width of basal endite, 3.0 times length of article 1, with 3 simple and 1 robust setae; article 3 same width as widest point of article 2, 2.1 times length of article 1, with 1 robust and 11 simple setae; article 4 narrower than article 3, 1.4 times length of article 1 with 6 simple setae; article 5 twice as long as wide, 1.8 times length of article 1, with 4 simple setae and 1 thick distal seta. Epipod with broad rounded tip, length 2.9 times width and 1.2 times basis length.

Pereopod 1 basis 0.2 body length; ratio of lengths of articles, basis to dactylus, 1.0:0.4:0.2:0.4:0.4:0.2; basis with 5 simple setae; ischium with 7 simple setae of various lengths, all distal; merus with 3 simple setae on distal superior margin and medially, at least 4 simple and 2 long pectinate setae; carpus width subequal throughout, with 3 long and 2 short simple setae on distal superior margin and inferior margin with at least 7 simple and 13 pectinate setae of different lengths, with small fringed scale-setae between; propodus width subequal throughout, superior margin with 11 long simple setae and inferior margin with 4 robust flagellate setae, at least 20 simple setae of various lengths and with small fringed scale-setae between on margin; dactylus with 8 short simple setae.

Pereopod 2 basis 0.2 body length; ratio of lengths of articles, basis to dactylus, 1.0:0.8:0.4:0.7:0.3:0.2; basis with 7 simple and 1 distal short flagellate seta; ischium with 5 simple setae and at least 5 short flagellate setae; merus with at least 9 simple setae of different lengths;

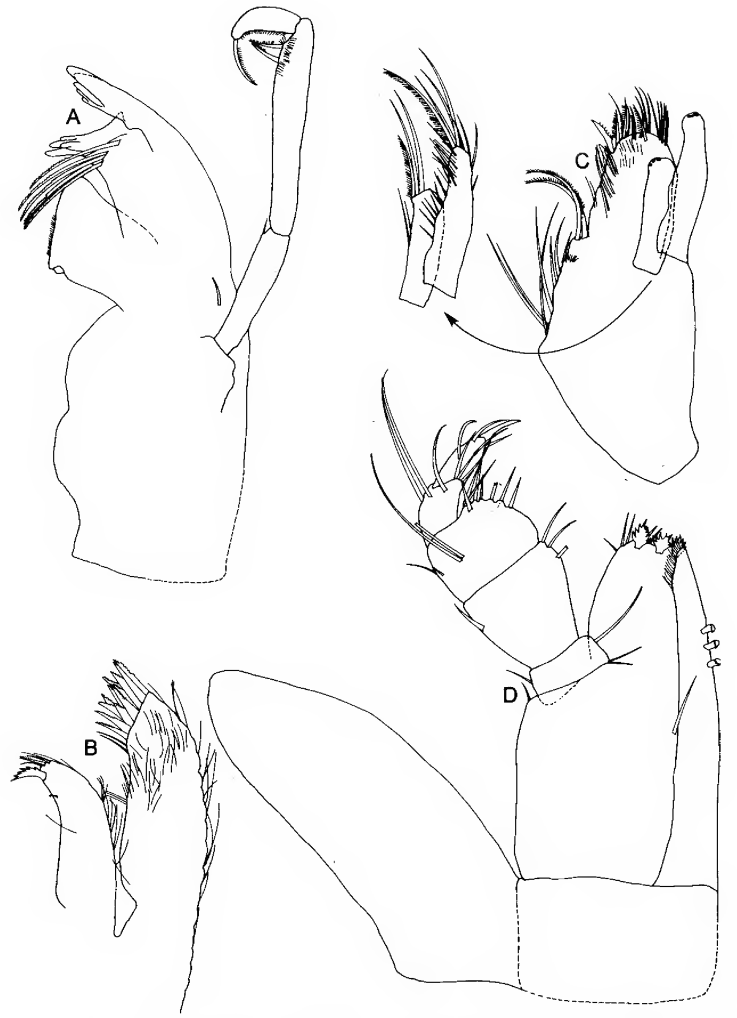

Figure 13. *Ischnomesus justi* sp. nov., female holotype, NMV J20306: A, mandible; B, maxilla l; C, maxilla 2; D, maxilliped (right).

carpus with at least 16 simple setae of various lengths, at least 3 robust flagellate setae, 1 of these on distal inferior margin and 1 brush seta on distal superior margin; propodus with 20 simple setae and 5 short robust flagellate setae on inferior margin; dactylus with 4 simple setae.

Operculum length 1.3 times maximum width; heart-shaped, margin with small simple setae, 4 slightly longer simple setae on posterior margin. Pleopod 3 exopod small and slender, 0.3 times endopod length; endopod elongate, rounded distal margin. Pleopod 4 elongate, length 2.7 times maximum width.

Uropod of 1 article, straight, 0.4 times length of pleotelson; sitting up in socket almost 90° degrees to body, with 4 simple setae.

Immature male. Pereopod 1 more slender than in female; ratio of lengths of articles, basis–dactylus, 1.0:0.3:0.2:0.5:0.4:0.2; basis with 6 simple setae; ischium with 3 long simple setae; merus with 2 long simple setae on distal superior margin and medially 2 long simple setae and 2 long pectinate setae; carpus width subequal throughout, with 2 long simple setae on distal superior margin, inferior margin with at least 20 pectinate setae of various lengths and small fringed scale-setae between; propodus with 17 simple setae of different lengths and inferior margin with 4 fringed scale-setae and 3 short, robust flagellate setae; dactylus with 5 simple setae.

Pleopod 1 length 2.6 times maximum width; completely fused, with no ornamentation, margin slightly compressed, widens towards distal end and curves inwards, indenting in the middle. Pleopod 2 sympod length 2.6 times maximum width, with 1 small simple seta; exopod rounded distally, 0.1 times as long as sympod; stylet, undifferentiated, fused with endopod, rounded distally. Pleopod 3 exopod short, length 0.4 times that of endopod; endopod distal margin coming to a wide point. Pleopod 4 elongate, length 2.0 times width.

Distribution. South-eastern Australia, from Nowra, New South Wales, to Cape Tourville, Tasmania; 841–1264 m depth.

Etymology. For Jean Just, distinguished isopod taxonomist, who sorted and made preliminary identifications of the material on which this study is based.

Figure 14. *Ischnomesus justi* sp. nov., female holotype, NMV J20306: A, pereopod 1; B, pereopod 2 Male paratype, NMV J J20309: C, pereopod 1.

Remarks. Although the uropods of *Ischnomesus* justi have only one article, the species displays all the other diagnostic characters that characterise *Ischnomesus*. *Ischnomesus justi* is similar to *I. calcificus* Menzies and George, 1972 and *I. simplex* Menzies and George 1972 (both species from the Peru–Chile Trench) and *I. roseus* Wolff, 1962 (from the Gulf of Panama and Eastern Pacific Ocean, off Costa Rica). There are many characters that link these four: pereonites 2–4 rounded, with pereonite 1 having either small spines or tubercles; *I. calcificus, I. justi* and *I. roseus* all have a three-articled mandibular palp (not illustrated in *I. simplex*) with two pectinate setae on the distal inferior margin; and pereopod 1 in both *I. calcificus* and *I. justi* has scale-setae on the inferior margin of the carpus and propodus. The uropods are undescribed for *I. calcificus* and *I. roseus*, and are of two articles in *I. simplex*. *I. justi* is distinguished from the others by the uropod having a single article, pereonites 1–4 being broadly rounded, and the pleotelson with only slight lateral bulges and an anterior keel.

Stylomesus Wolff

Stylomesus Wolff, 1956: 97.—Birstein, 1960: 15.—Menzies, 1962: 123.—Wolff, 1962: 83.—Birstein, 1971: 204.—Kussakin, 1988: 437.
Gomphomesus.—Wolff, 1962: 84.
Helomesus.—Wolff, 1962: 84.

Type species. Rhabdomesus inermis Vanhöffen, 1914 (by monotypy).

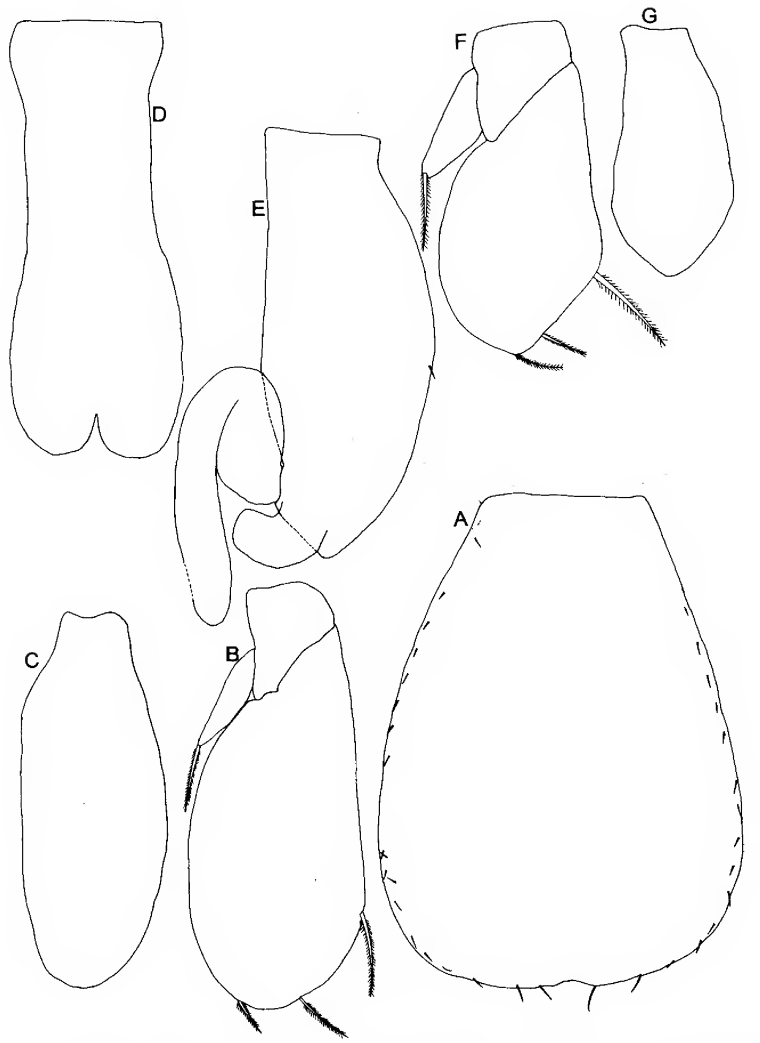

Figure 15. *Ischnomesus justi* sp. nov., female holotype, NMV J20306: A, Operculum; B, pleopod 3; C, pleopod 4. Male paratype, NMV J20309: D, pleopod 1; E, pleopod 2: F, pleopod 3 (right); G, pleopod 4 (right).

Diagnosis. At least pereonite 7 fused with pleon. Antenna 1 with 6 articles. Antenna 2 supported by anterolateral projections extending from head. Mandibular palp absent. Maxilliped basis endite large, wider than palp, palp articles 2 and 3 not expanded. Pereopod 1 carpus width usually subequal throughout length. Stylet of male pleopod 2 not extending past distal margin of sympod. Uropod long and of 2 articles.

Remarks. The fusion of at least pereonite 7 to the pleotelson and the autapomorphy of the presence of anterolateral projections extending from the head and supporting the antennae is a modification of Wolff's original description but agrees with that given by Kussakin (1988).

Stylomesus sarsi sp. nov.

Figures 16–20

Material examined. Holotype. Tasmania., continental slope (40°45′S, 149° 09.3′E – 40° 46.54′S 149°00.27′E), 3000–2400 m, WHOI epibenthic sled, P. Hutchings et al., RV *Franklin*, 10 Dec 1986 (stn FR1086–4), AM P63900 (male, 5 mm).

Paratypes. Collected with holotype, AM P63901 (1 female, 5 mm; 1 male, 5 mm).

Other material. Australia, Tasmania., 48 km ENE of Cape Tourville (42°00.25′S, 148°43.55′E), 1264–1130 m, gravel with lumps of sandy mud aggregate (stn SLOPE 81), NMV J20299 (2 females, 1 male, 1 fragment). Tasmania., continental slope, 40°45′S, 149°09.3′E –40°46.54′S, 149°00.27′E, 3000–2400 m, (stn FR1086-4), AM

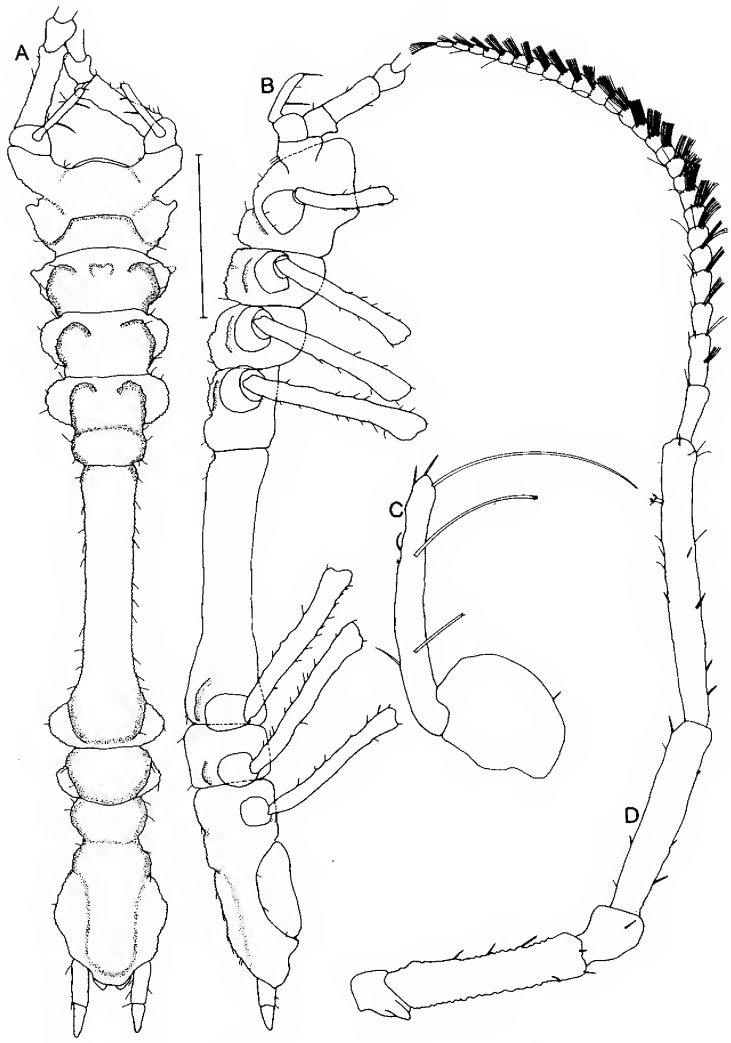

Figure 16. *Stylomesus sarsi* sp. nov., male holotype, AM P63900: A, dorsal view; B, lateral view; C, antenna 1; D, antenna 2. Scale bar = 1 mm, dorsal and lateral views only.

P63902 (17 females, 8 males, 22 fragments). NSW, 67 km ENE of Nowra (34°41.97′S, 151°22.44′E), 1896–1642 m (stn SLOPE 59), NMV J20294 (8 females, 2 fragments). Off Nowra (34°58.40′S, 151°23.20′E), 1750–1650 m, (stn SLOPE 15), NMV J20291 (1 fragment). Vic., 67 km S of Point Hicks (38°23.95′S, 149°17.02′E), 1277–1119 m, fine mud (stn SLOPE 67), NMV J20296 (7 females, 1 fragment). 76 km S of Point Hicks (38°29.33′S, 149°19.98′E), 1840–1750 m, sandy mud, fine shell (stn SLOPE 69), NMV J20297 (12 females, 2 males, 7 fragments), NMV J20298 (4 females, 2 males, 1 fragment). 96 km S of Point Hicks (38°40.29′S, 149°18.06′E), 2900–2900 m, compacted clay (stn SLOPE 66), NMV J20295 (8 females, 8 fragments). S of Point Hicks (38°25′S, 149°0′E), 1500 m, compacted clay (stn SLOPE 27), NMV J20293 (12 females, 2 males, 7 fragments). S of Point Hicks (38°25.90′S, 148°58.60′E), 1850 m, muddy, sandstone (stn SLOPE 25), NMV J20292 (1 male).

Diagnosis. Body granulate, about 7 times as long as wide. Head+pereonite 1 bearing 2 anterolateral extensions supporting antennae. Pereonites 1 and 2 with pair of stout anterolateral spines. Pereonites 2–4 each with pair of elevated dorsal bosses. Pereonites 4 and 5, about 1.4 and 4.5 times length of pereonite 2 respectively. Pleotelson longer than wide, with wide medial ridge. Antenna 2 articles 2 and 3 length subequal, article 3 about quarter length of article 4, flagellum of 26 articles, each setose. Mandible molar quadrangular, with broad face. Maxilliped with fringe of fine simple setae on basis, palp article 1 widest, with each article narrower than the previous. Pereopod 1 merus with 2 robust setae on distal inferior margin, carpus width generally subequal throughout length, 0.4 length of basis, bearing 1 long robust seta and 3 smaller, robust flag-

Figure 17. *Stylomesus sarsi* sp. nov., male paratype, AM P63901: A, mandible; B, maxilla l; C, maxilla 2; D, maxilliped.

ellate setae. Pereopods 2–7 slim, carpus with finely serrate distal margin. Uropod with 2 articles, article 2 0.8 times length of article 1.

Description of male holotype. Body length 6.5 times maximum width of pereonite 3. Body cuticle highly granulated, calcified and brittle, with all pereonites bearing short simple setae. Head+pereonite 1 1.7 times as wide as long, with 2 anterolateral projections of head supporting antennae. Ratio of lengths of pereonites 2 : 3 : 4 : 5 : 6 : 7+pleon, 1.0:1.0:1.4:4.5:0.9:2.8. Pereonites 1 and 2 with pair of stout anterolateral spines. Pereonite 2 slightly narrower than pereonite 1, pereonites 2–4 widths subequal (excluding anterolateral spines), 5–7 decreasing posteriorly Pereonites 2–4 each with pair of raised dorsal bosses. Pleotelson oval in dorsal view, length 1.1 times width, with wide, medial longitudinal ridge; posterior margin with 2 subventral lobes.

Antenna 1 article 1 broad, roughly oval, bearing 1 simple seta; article 2 length 2.2 as long and 0.25 times as wide of article 1, bearing 3 long flagellate setae and 5 shorter simple setae. Antenna 2 of 31 articles; article 1 small, lacking setae, with a lateral protrusion; article 2 granulated, 5.5 times as long as article 1, with 6 simple setae; article 3 short, 1.7 times as long as article 1 with 1 simple setae; article 4 5.6 times length of article 1, with 7 simple setae; article 5 longest, 8.0 times as long as article 1, with many simple and 2 distal brush setae; flagellum of 26 articles decreasing in length, each setose.

Mouthparts (of male paratype). Mandible incisor process with 5 cusps; lacinia mobilis with 4 cusps; spine row of 4 spines; molar wide, rectangular, with broad, distal grinding surface with 3 fine simple setae on face and proximally 6 fine simple setae. Maxilla 1 with mesial lobe 0.6 times width of lateral lobe; both lobes with numerous fine simple setae on inferior and superior margins; mesial lobe distal margin with 1 short dentate and 1 simple setae; lateral lobe with 12 distal, robust, dentate setae. Maxilla 2 lateral lobe with several rows of microtrichs on superior margin; middle lobe 0.9 times width of lateral lobe, no

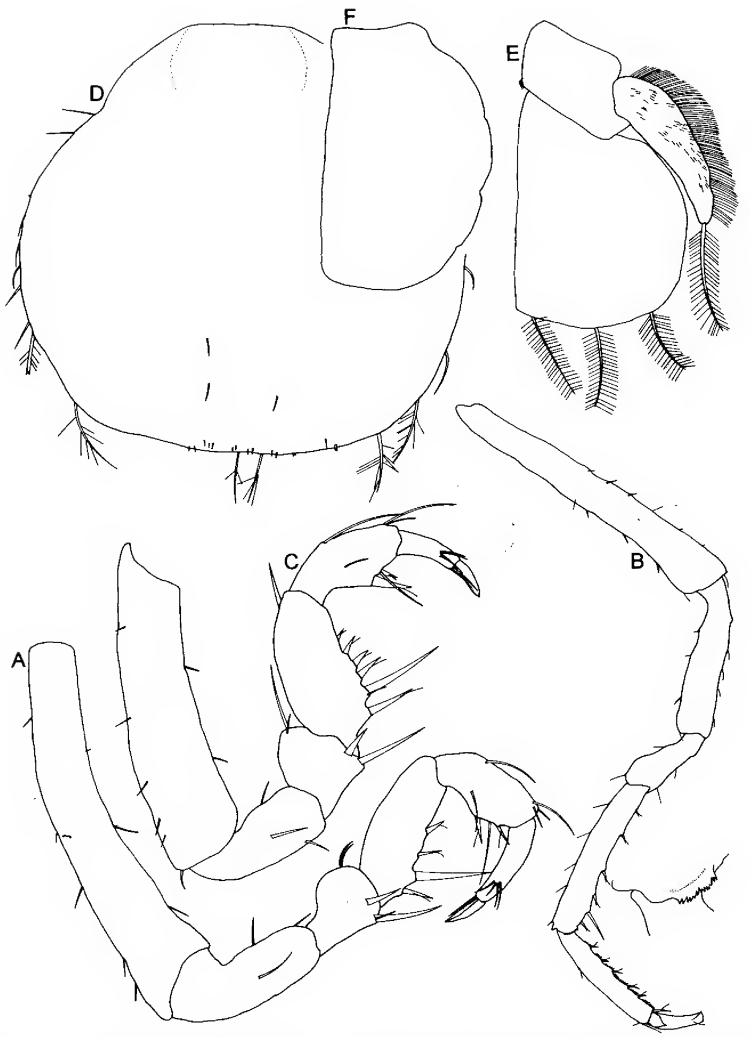

Figure 18. *Stylomesus sarsi* sp. nov., male holotype, AM P63900: A, pereopod 1; B, pereopod 2. Female paratype, AM P63901: C, pereopod 1; D, operculum; E, pleopod 3 (right); F, pleopod 4.

ornamentation, both lateral and middle lobes with 4 distal pectinate setae of different lengths; mesial lobe with many microtrichs and fine simple setae covering surface, 2 long, pectinate setae set medially on inferior margin, and distally, 3 dentate, 2 small pectinate and 6 simple setae. Maxilliped coxa small, rectangular; basis 1.8 times as long as widest point, with fringe of fine simple setae on superior margin and in its surface, endite with 3 coupling hooks and distally 3 fan and 3 simple setae. Palp tapering, 2.4 times length of basal endite; palp article 1 shortest, almost rectangular bearing 2 simple setae; article 2 0.5 times as wide as maximum width of basal endite and width equal to and 1.4 times length of article 1, with 2 simple setae and few fine simple setae; article 3 as wide as and 1.8 times as long as article 1, with 1 simple setae and 1 stronger distal seta on inferior margin and numerous fine simple setae; article 4 1.6 times length of article 1, narrower than article 3, with 2 distal simple setae and numerous fine simple setae; article 5 narrower than article 4, 1.3 times the length of article 1, with 1 thick distal seta and 4 slightly thinner simple setae. Epipod length 2.8 times width, 1.1 times basis length, with proximal end square, distal tip curved inward and a few microtrichs.

Pereopod 1 basis 0.1 body length; ratio of lengths of articles, basis–dactylus, 1.0:0.4:0.2:0.4:0.3:0.2; basis with 8 simple setae; ischium with 3 simple setae; merus with 2 simple and on inferior distal margin, 1 simple and 2 long, robust setae; carpus width subequal throughout, inferior margin with 3 flagellate robust setae and 1 long robust seta; propodus width subequal throughout, with 4 simple setae on superior margin, 1 simple seta on surface and inferior margin with 2 flagellate, robust and 1 long simple seta; dactylus with 4 short simple setae on distal superior margin.

Pereopods 2–7, basis 0.2 body length; ratio of lengths of articles, basis to dactylus, 1.0:0.5:0.3:0.6:0.4:0.2.

Pereopod 2 basis with 12 simple setae; ischium with 8 simple setae; merus with 4 simple setae; carpus with 5 simple setae on superior

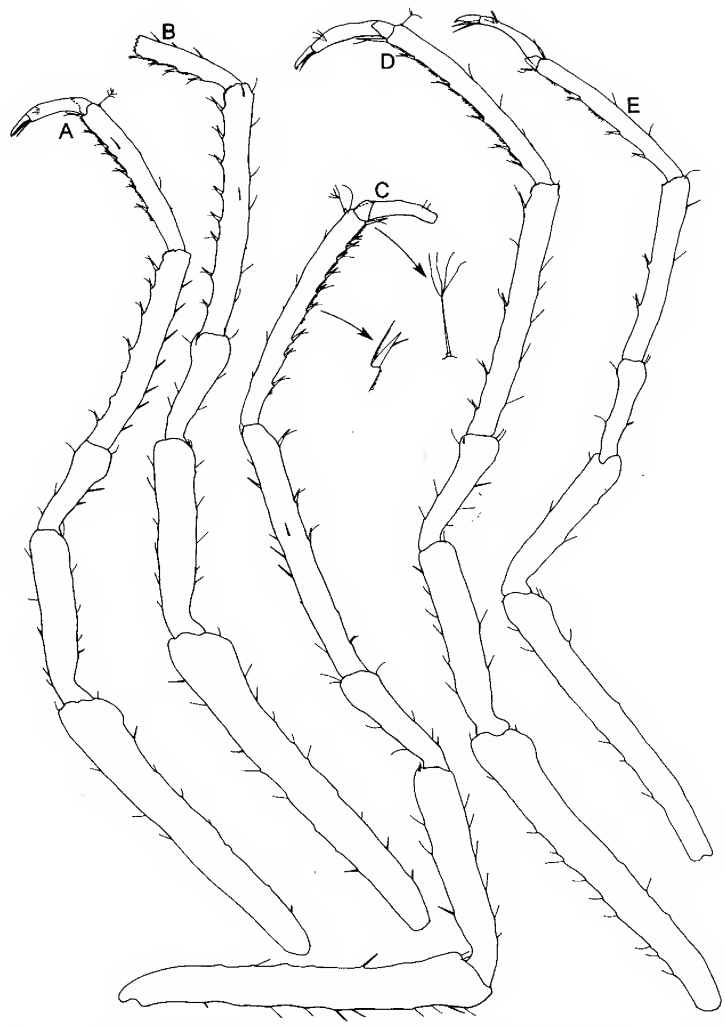

Figure 19. *Stylomesus sarsi* sp. nov., male holotype, AM P63900: A, pereopod 3 (right); B, pereopod 4; C, pereopod 5; D, pereopod 6; E, pereopod 7 (right).

margin and on inferior margin 5 flagellate robust and 1 long, robust seta, distal margin finely serrate; propodus with 3 simple setae on superior margin, 6 flagellate robust setae with small fringed scale-setae between each on inferior margin; dactylus with 2 short distal setae.

Pereopod 3 basis with 10 simple setae; ischium with 10 simple setae; merus with 6 simple setae; carpus with 7 simple setae on superior margin and at least 5 flagellate robust setae on inferior margin, distal margin finely serrate; propodus with at least 2 simple setae, inferior margin with 7 flagellate robust setae with fringed scale-setae between each and 1 brush seta on distal superior margin; dactylus with 4 small distal simple setae.

Pereopod 4 basis with 15 simple setae; ischium with 13 simple setae; merus with 8 simple setae; carpus with at least 8 simple setae and inferior margin with 8 flagellate robust setae, distal margin finely serrate; half of propodus intact with superior margin with 3 simple setae and inferior margin with 4 flagellate robust setae with fringed scale-setae between them.

Pereopod 5 basis with 13 simple setae; ischium with 11 simple setae; merus with 8 simple setae; carpus with at least 8 simple setae and at least 4 flagellate robust setae on inferior margin; propodus with 6 simple setae, 10 flagellate robust setae with fringed scale-setae between them and 1 brush seta on distal superior margin; dactylus superior margin with 2 small simple setae.

Pereopod 6 basis with 13 simple setae; ischium with 9 simple setae; merus with 9 simple setae; carpus superior margin with 6 simple setae and inferior margin with 1 simple and 4 flagellate robust setae, distal margin finely serrate; propodus with 4 simple setae on superior margin, 6 flagellate robust setae with fringed scale-setae between each on inferior margin and 1 brush seta on distal superior margin; dactylus with 3 small simple setae.

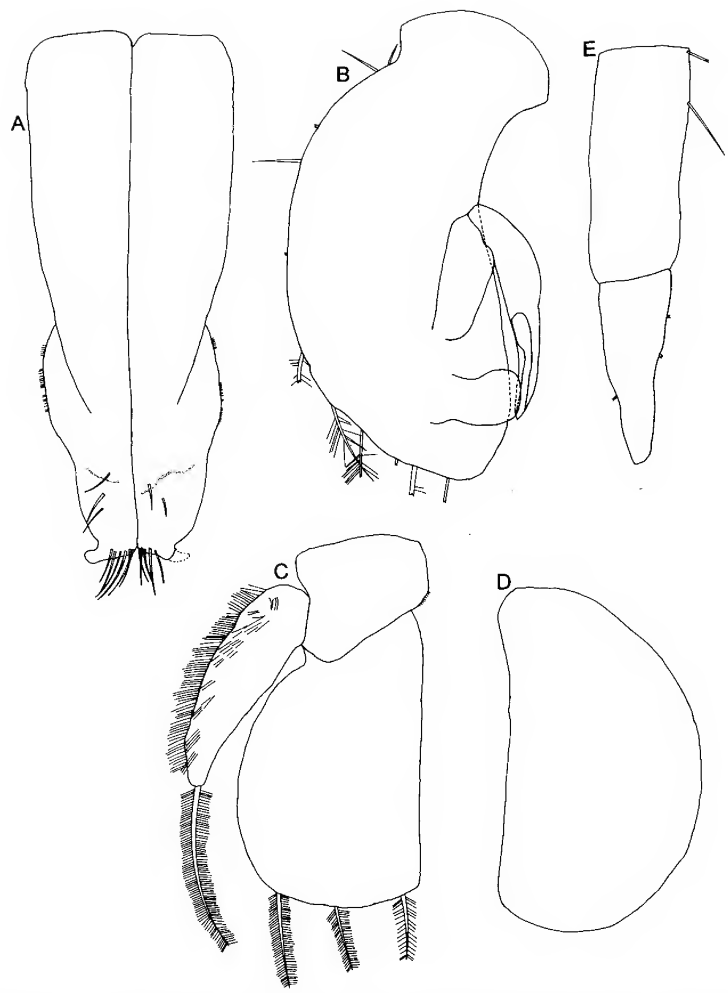

Figure 20. *Stylomesus sarsi* sp. nov., male holotype, AM P63900: A, pleopod 1; B, pleopod 2; C, pleopod 3; D, pleopod 4; E, uropod (right).

Pereopod 7 basis with at least 8 simple setae; ischium with 3 simple setae; merus with 5 simple setae; carpus with 3 simple setae on superior margin, 2 flagellate setae on inferior margin and distal margin finely serrate; propodus with 3 simple setae on superior margin and on the inferior margin, 4 flagellate robust setae with some fringed scale-setae between; dactylus with 4 small distal simple setae.

Pleopod 1 length 2.6 times maximum width; margins indent at 0.6 of length from proximal end; 5 simple setae near a small transverse ridge near distal margin; 6 simple setae on right and 5 simple setae on left of distal margin; prominent distolateral horns. Pleopod 2 sympod length 2.2 times maximum width; lateral margins curved, with few simple setae and 6 distolateral, plumose setae; exopod short, 0.1 times sympod length, rounded distally; stylet 0.4 length of sympod tapering to a point; sperm duct 0.5 length of stylet. Pleopod 3 exopod length 0.7 times endopod length with a fringe of fine simple setae on surface and extended from superior margin. Pleopod 4 length 1.8 times width.

Uropod straight, 0.6 times length of pleotelson; article 1 with 2 simple setae; article 2 tapering, 0.8 times length of article 1, with 3 simple setae.

Female. Pereopod 1 shorter and more robust than in male; ratio of lengths of articles, basis–dactylus, 1.0:0.4:0.2:0.5:0.4:0.2; basis with 8 simple setae; ischium with 3 simple setae; merus with 2 simple setae on distal superior margin and 2 long robust setae on distal inferior margin; carpus slightly broader at proximal end, 1 long robust seta on superior margin, inferior margin with 1 simple seta, 5 robust flagellate setae and 1 long robust seta; propodus with 5 simple setae and 2 flagellate, robust setae on inferior margin; dactylus narrower than propodus, with 4 short simple distal setae.

Operculum slightly wider than long, length 0.9 times maximum width; curves to slight keel at apex, with few simple setae on lateral margins, plumose setae and microtrichs on posterior margin. Pleopod 3 similar to male, exopod length 0.8 times endopod. Pleopod 4 length 1.6 times width, with 3 slight dents on lateral margin.

Distribution. South-eastern Australia, from Nowra, New South Wales, to Cape Tourville, Tasmania; 1119–3000 m depth.

Etymology. In honour of the Norwegian carcinologist, Georg

Ossian Sars (1837–1927), the first person to describe taxa of Ischnomesidae.

Remarks. Stylomesus sarsi is the first species of *Stylomesus* recorded from Australian waters. It resembles *Stylomesus natalensis* Kensley, 1984 from south-western Indian Ocean off South Africa. Both species have granulate integuments, short anterolateral spines on pereonites 1 and 2 and in both the mandible molars have a broad distal surface. However, *S. sarsi* can be distinguished from *S. natalensis* by the lack of tubercles set medially on pereonites 1 and 2, less elongate pleotelson, and longer flagellum of antenna 2. The maxilliped palp of *S. sarsi* has setae present on all articles, while on *S. natalensis*, setae are present only on the last three articles.

Acknowledgements

This contribution results from material collected as part of a wide-ranging exploration of the continental slope of south-eastern Australia, commenced in 1984, and supported by grants from the Australian Research Grants scheme and by the then Victorian Institute of Marine Sciences. We acknowledge the considerable effort devoted to the project by Jean Just (Museum Victoria, now of Museum of Tropical Queensland, Townsville) who extracted most of the animals from the samples and sorted the isopods to putative species. We are grateful to the RV *Franklin* Steering Committee and to CSIRO Marine Laboratories, Hobart, for the provision of ship-time and to the master and crew of the vessel for help aboard. We are also grateful to Niel Bruce (NIWA, Wellington) and the anonymous reviewers for reviewing the manuscript and providing feedback.

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New genera and species of sphaeromatid isopod crustaceans from Australian marine coastal waters

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Abstract

Bruce, N.L. 2003. New genera and species of sphaeromatid isopod crustaceans from Australian marine coastal waters. *Memoirs of Museum Victoria* 60(2): 309–369.

Australia has a great diversity of sphaeromatid isopods, both in terms of species and genera, with 187 recorded species and subspecies in 58 genera. This contribution records and describes a further four genera: *Austrasphaera* gen. nov., *Cassidias* Richardson, 1906, *Koremosphaera* gen. nov. and *Pedinura* gen. nov. and ten new species: *Austrasphaera berentsae* sp. nov., *A. springthorpei* sp. nov., *Cassidias australiensis* sp. nov., *Exosphaeroma agmokara* sp. nov., *Exosphaeroma alveola* sp. nov., *Koremosphaera colonus* sp. nov., *Margueritta sandyi* sp. nov., *Moruloidea perionasus* sp. nov., *Pedinura flindersia* sp. nov. and *Pedinura mokari* sp. nov. Several appear to be common and widely distributed, with both species of *Austrasphaera* and *Pedinura flindersia* ranging from Vic. to WA; *Pedinura mokari* is recorded from Vic. and SA while *Cassidias australiensis* is recorded from the NT to the North-West Shelf, WA. The remaining species are restricted to or near to their type locations. A brief diagnosis is given for *Exosphaeroma* and an annotated list of all accepted species is provided, including incertae sedis species and some recent exclusions from this genus.

Key words

Taxonomy, Isopoda Sphaeromatidae, *Austrasphaera, Cassidias, Koremosphaera, Pedinura, Exosphaeroma*, Australia

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Introduction

Over the last two decades of the twentieth century Museum Victoria and the Australian Museum made extensive shallow-water collections from southern Australian coastal regions from New South Wales to southern Western Australia. The collectors used fine-scale collecting techniques such as epibenthic sleds and in shallow coastal waters, SCUBA, which resulted in a wealth of undescribed crustacean material. These collections include new species many of which, though not collected previously, proved to be widely distributed and common. This contribution draws principally from these collections, but is supplemented by material from the South Australian Museum, Adelaide and some collected by myself.

Australia has a rich sphaeromatid fauna (Poore et al., 2002) that displays extraordinary morphological diversity. The documentation of this fauna results from three discrete periods of research – by Baker (1908–1929), Harrison and Holdich (1980–1984 in either combination) and Bruce (1982 to the present). Poore et al. (2002) listed 187 species and subspecies of Sphaeromatidae which, together with the species described herein, are nearly 28% of all sphaeromatid species known world-wide, and approximately 17% (the figures are continually changing) of all isopod species known from Australia. It is

estimated that this may represent less than 50% of the potential total.

Methods follow those outlined in Bruce (1994a, 1995, 1997). Abbreviations are: AM, Australian Museum, Sydney; NTM, Museum and Art Gallery of the Northern Territory, Darwin; NMV, Museum, Victoria, Melbourne; QM, Queensland Museum, Brisbane; SAM, South Australian Museum, Adelaide; WAM, Western Australian Museum, Perth; CP, circumplumose; PMS, plumose marginal setae; RS, robust seta/setae; SEM, scanning electron microscope.

Austrasphaera gen. nov.

Type species. Austrasphaera berentsae sp. nov., here designated.

Diagnosis. Anterior margin of head overriding antennule and antennae bases. Pleon with all segments entirely fused, with no visible sutures, entirely fused to pleotelson. Antennule peduncle articles 1 and 2 subequal in length, each about twice as long as article 3; article 3 posteriorly offset. Pereopods basis and ischium subequal in length, short, about two-thirds as long as propodus. Pleopod 1 operculate, rami collinear, endopod with mesial margin indurate. Male appendix masculina massive, 0.8–1.0 as wide as endopod, 1.2–1.5 times as long as endopod, distally widest. Uropods subterminal.

Description of female. Body elongate, 3–4 times as long as greatest width, strongly vaulted; dorsal surface smooth; lateral margins subparallel to weakly ovate; unable to conglobate. Head weakly to strongly anteriorly produced, weakly immersed in pereonite 1, anteriorly overriding antennule and antennal bases; rostral process minute. Eyes small, lateral. Pereon segments without raised posterior margins. Coxal plates distinct, overlapping anterior over posterior. Membrana cingula absent. Pleotelson without foramen or excision, but with shallow ventral exit channel. Pleonal sternite present.

Antennule and antenna in ventral position on head. Antennule peduncles narrowly separated by epistome; peduncle articles 1 and 2 robust, anteriorly flattened, expanded; article 2 inferodistal angle produced forming a lobe, plane of articles 1 and 2 of projecting ventrally; peduncle article 3 short, about 0.17 as long as articles 1 and 2, posteriorly offset at midpoint of article 2; flagellum of 3 articles. Antenna slender, held beneath body, peduncle articles 1–3 short, together about 1.3 times as long as article 4, article 5 longest; flagellum as long as or slightly shorter than peduncle.

Epistome narrow, unornamented, anteromedian portion weakly produced. Labrum unornamented. Mandible incisor unicuspid or with weakly defined cusps; left mandible with or without prominent lacinia mobilis; molar process smooth, without serrations or ridges; palp article 1 longest, 3 shortest. Maxillule with lateral lobe with 13 RS on gnathal surface, mesial lobe with 2 long CP slender setae and 1 short slender seta. Maxilla with all articles well developed; lateral and middle lobes with flat finely serrate RS, mesial lobe with blunt and acute long RS, some of which are basally CP. Maxilliped endite distally with cactus and club setae, laterally with 1 long curved CP seta; palp articles not mesially produced, mesial margins with numerous setae, lateral margins without setae.

Pereopods all robust, inferior margins flattened; dactylus with prominent recurved trifid secondary unguis; propodus longest, about 1.0–1.6 times as long as basis. Pereopods lacking serrate and trifid RS.

Brood pouch composed of an anterior and posterior pocket.

Pleopods with all rami elongate, pleopods 1–3 with PMS, 4 and 5 without PMS. Pleopod 1 exopod 1.3–1.6 as long as endopod, endopod about half as wide as exopod, apex distally narrowed. Pleopods 3 and 4 without transverse suture. Pleopods 4 and 5 exopod and endopods with transverse thickened ridges; pleopod 5 endopod with 2 scale patches and transverse suture. Uropods endopod and exopod lamellar, exopod smaller than endopod.

Male. Similar to female except for sexual characters. Pleopod 2 appendix masculina basally or subbasally attached. Penes short, adjacent, basally not widely separated. Pereopod 1 lateral margin with 2 proximally positioned submarginal serrate RS.

Composition. Austrasphaera berentsae sp. nov.; *A. springthorpei* sp. nov.

Etymology. From Latin *australis* (meaning south, in reference to the 'South Land', i.e., Australia), with the ending *-sphaera* indicating the family affinity (feminine).

Remarks. This distinctive genus is characterised by the following characters: elongate and strongly vaulted body; pleonite and pleotelson entirely fused; posterior margin of the pleotelson entire; antennules ventrally positioned on head, with articles 1 and 2 expanded, plane of articles ventrally directed; antennule peduncle articles 1 and 2 subequal in size, article 2 with an anterior lobe and article 3 posteriorly offset on article 2; pereopods robust with a very short basis and a long propodus; operculate pleopods, pleopod 2 exopod about half as long as endopod, in the male endopod with a massive appendix masculina; pereopods 5–7 without the usual serrate and trifid setae; and uropods with the exopod smaller than the endopod (but not minute).

Pleopods 4 and 5 have thickened ridges on both rami placing this genus within the broad subfamily concept of Dynameninae Bowman, 1981. Bruce (1995) defined the *Ischyromene*-group, an informal grouping of genera within the Dynameninae. *Austrasphaera* shows all the characters of that group of genera: proportions of the antennule peduncle articles, pleopod 1 with the endopod mesial margin being indurate, and pleopod 2 with the exopod distinctly shorter than the endopod. *Austrasphaera* is similar to four southern Australian genera (*Juletta* Bruce, 1993, *Maricoccus* Poore, 1994 and *Margueritta* Bruce, 1993) which share: anterior margin of the head produced, overriding the antennule and antennal peduncles, antennule peduncle article 3 being posteriorly offset (also present in *Diclidocella* Bruce, 1995, and some species of *Cymodocella* Pfeffer, 1887, see Bruce, 1995), pleopod 1 being operculate, pereopods 5–7 with none (or very few) trifid or serrate setae and the pleotelson largely fused to the pleon. The body shape of the four genera varies from scale-like in *Maricoccus*,

flattened in *Juletta*, vaulted in *Margueritta*, to elongate and semicylindrical in *Austrasphaera*.

Two South African species, incorrectly placed in *Dynamenella*, are similar to *Austrasphaera* and to the *Ischyromene*-group. These are *"D." taurus* Barnard, 1940 and *"D." navicula* Barnard, 1940. *"D." taurus* has a similar antennule with peduncular article 2 being large and anterodistally produced, and the anterior margin of the head produced with ventral antennules and antennae (rather than anterior). *"Dynamenella" navicula* has a similar head and body shape to *Austrasphaera*, but those appendages that were figured by Barnard otherwise differ. Both species have a pleon with four segments and collinear antennule peduncle articles; pereopod and pleopod morphology is unknown and further comparison is not possible without the redescription of the South African species.

Austrasphaera berentsae sp. nov.

Figures 1–4

Material examined. Holotype. Female (ovigerous 3.6 mm), Vic., Bay of Islands, 38°35.0′S, 142°49.5′E, 28 Apr 1988, 2.5 m, red algae, R.T. Springthorpe and P.B. Berents (AM P51061).

Paratypes. **Vic.** 10 males (2.4–2.5 dissected, 2.6 mandibles dissected, 2.8 mm), female (ovigerous. 3.5 mm, dissected), same data as holotype (AM P41342). 8 females (ovigerous 3.5–3.8 SEM, 3.9 SEM, 3.9 mm), 1 km E of Harmers Haven, 38°34′S, 145°40′E, 6 Mar 1982, 6 m, 300 m offshore, rocky, R.S. Wilson and C. Larsen (NMV J26391). Female (3.7 mm), same data as previous (NMV J26394). Male (2.8 mm), same data as previous, but 11 m (NMV J26229). Male (2.9 mm), female (3.4 mm), 50 m E of Petrel Rock, Venus Bay, 38°39′S, 145°42′E, 5 Mar 1982, 8 m, rocky, M. MacDonald, M. Gomon and G. Barker (NMV J26393). Male (2.8 mm), female (3.5 mm), 75 m SW of Eagles Nest, Venus Bay, 38°40′S, 145°40′E, 5 Mar 1982, 8 m, rocky, R.S. Wilson and G. Barker (NMV J26390). Male (2.5 mm), 50 m offshore, east side of S point, Twin Reefs, 38°41′S, 145°39′E, 11 m, C. Larsen, G. Barber and R.S. Wilson (NMV J26395).

Non-type material. **Vic.** Laurence Rocks, Portland, 38°34.0′S, 141°40.5′E, 23 m, *Herdmania momus* with encrusting sponge and red algae (AM P41379). Whalers Point Lighthouse, Portland, 38°20.5′S, 141°37.5′E, 10 m, brown algae from boulder bottom (AM P41399). **SA.** "The Hotspot" reef, Flinders I., 33°40.8′S, 134°22.5′E, 21 m, large red algae (NMV J39716); 33°40.5′S, 134°22.05′E, 12 m, assorted algae (NMV J39724); 33°40.5′S, 134°22.0′E, 17 m, algae, large forms (NMV J39696). NE end of West I., 35°37.0′S, 138°36.0′E, 12 m, red algae (NMV J39697). Western River Cove, Kangaroo I., 35°43′S, 137°35′E, 6 m, coralline algae (AM P51064). **WA.** Mississippi Bay, E of Esperance, 34°0.0′S, 122°170′E, ?2 m, algae (AM P41125). Point Peron, S of Perth, 32°16′S, 115°41′E, 4 m, *Posidonia* and algae (AM P51063). Green I., Rottnest I., 32°01′S, 115°30′E, mixed algal turf (AM P41113). Dongara–Port Denison Beach, 29°16.0′S, 114°55.0′E, 5 m, red algae, mainly *Laurencia* (NMV J26152); 3 m, drift red algae on sand (NMV J26168). Seven Mile Beach, Dongara, 29°12.0′S, 114°53.0′E, 1 m, epiphytes on *Amphibolus* (NMV J39700); D. Edgar (NMV J39698). Red Bluff, Kalbarri, 27°42′S, 114°0.9′E, 10 Jan 1984, mixed corallines (AM P51062).

Description of female. Body about 3.5 times as long as greatest width, ovate, widest at pereonites 3 and 4; dorsal surfaces smooth, without scattered setae. Cephalon anterior margin without transverse ridge, ventral rostral process weakly developed. Head and pereonites 1 subequal in length in dorsal view, pereonite 1 about twice as long as pereonite 2, with 1 or 2 low indistinct sublateral bosses; pereonites 2–7 of approximately equal length; pereonite 7 with low indistinct median boss; coxae with sutures, ventrally directed. Pleon with weak median boss, posterior margin indicated by short lateral sutures. Pleotelson posterior margin smoothly rounded; ventral margin with shallow exit channel not extending to posterior of pleotelson.

Antennule peduncle article 2 2.6 times as long as wide, about 1.3 times as long as article 2; article 2 flattened, inferior margin convex; inferior margins of both articles 1 and 2 with mass of flattened scales and fine tubular setae; article 3 about one-quarter as long as article 2, inserted midpoint of posterior margin; flagellum 3-articled, extending to pereonite 1, about 1.7 times as long as article 3. Antenna peduncle articles 1–3 short, combined lengths about equal to that of article 5; article 4 about 0.8 as long as article 5, both articles 4 and 5 with inferior margins convex; flagellum about equal in length to peduncle, extending to anterior margin of pereonite 2, with 8 articles.

Epistome smooth, narrow, laterally encompassing labrum, anteriorly truncate. Left mandible incisor without distinct cusps, lacinia mobilis without cusps, spine row of 3 serrate curved spines; right mandible with 3 indistinct cusps, spine row of 1 broad-based multidigitate spine and 3 serrate blunt spines; molar process irregular, largely smooth, without serrate margins or ridged surfaces; palp article 1 longest, without setae; article 2 with 4 biserrate setae, article 3 with 6 biserrate setae, terminal seta being largest. Maxillule mesial lobe with 2 long, weakly pectinate setae and 1 shorter simple seta; lateral lobe with 10 terminal and peripheral RS on gnathal surface, eleventh seta set between these; lateral most RS are weakly serrate on distal part of seta. Maxilla lateral lobe and middle lobe each with 3 and 4 curved RS respectively, mesial lobe with 6 RS, variously serrate, mesial-most seta only being acute, remainder terminally rounded. Maxilliped endite extending about half way along palp article 4, distal margin with 1 conical RS, 3 rounded RS, 2 cactus RS and 2 slender CP RS; palp articles 2–5 with about 10, 15, 14 and 11 setae respectively.

Pereopod articles generally with abundant widely-spaced microtrichs. Pereopod 1 basis about 1.7 times as long as greatest width, approximately half as long as propodus; inferodistal angle with 1 simple setae; ischium as long as basis, twice as long as greatest width; merus about 0.4 as long as ischium, 0.8 times as long as greatest width, carpus (inferior margin) 0.6 as long as merus, 0.5 as long as wide; propodus twice as long as ischium, 3 times as long as greatest width; dactylus about half as long as propodus, unguis strongly recurved, inferior margin with prominent serrate cuticular scales, secondary unguis recurved with 2 basal cusps. Pereopods 2 and 3 similar to pereopod 1; pereopod 2 with 1, 1 and 4 setae on inferior margins of merus, carpus and propodus respectively; pereopod 3 with 2, 2 and 3 setae on inferior margins of merus, carpus and propodus respectively. Pereopods 5 and 6 similar, shorter than pereopods 1 and 2. Pereopod 6 propodus inferior margin without setae. Pereopod 7 short, slightly longer than pereopod 6, articles robust and laterally flattened, merus slightly shorter than wide,

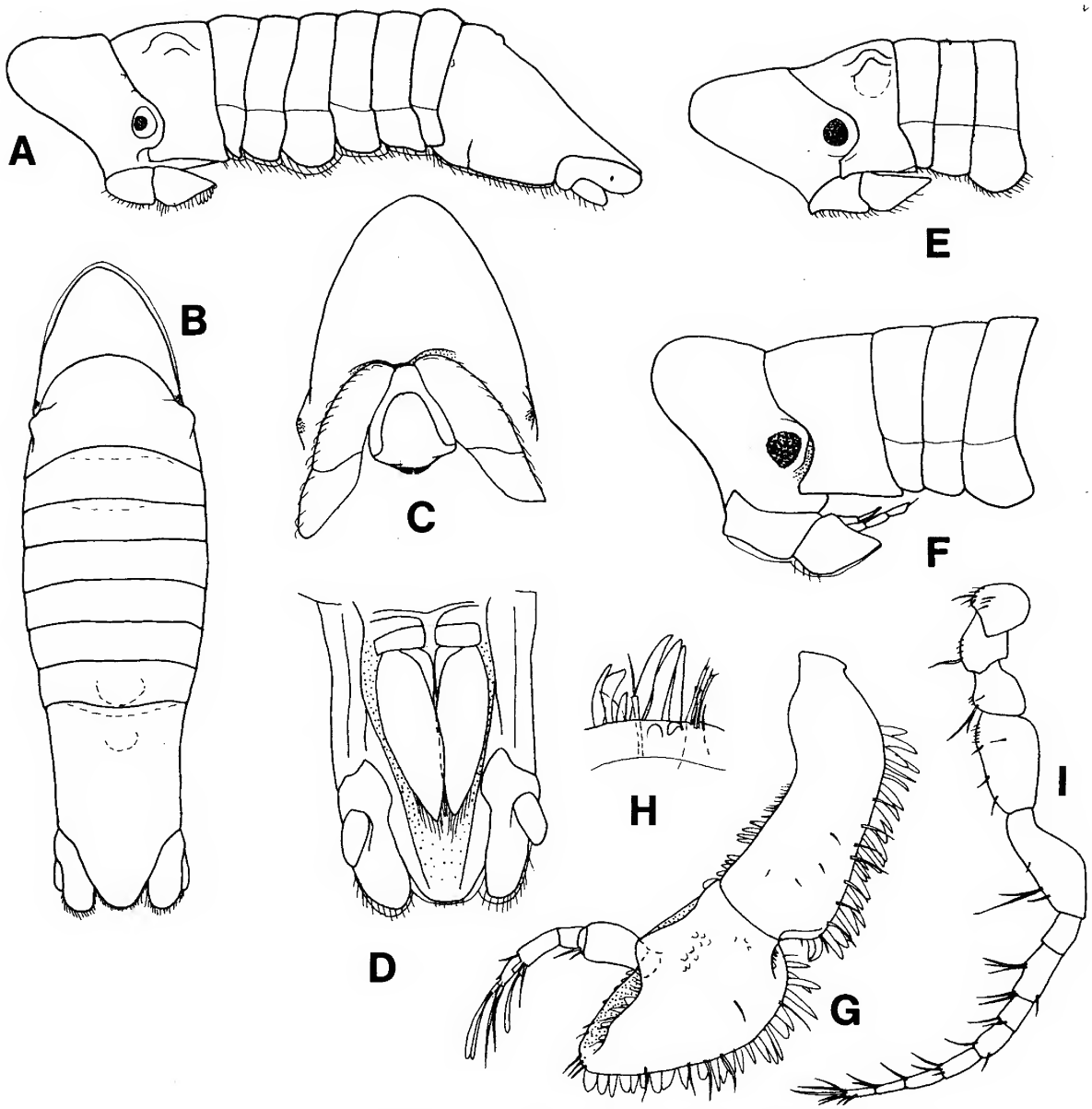

Figure 1. *Austrasphaera berentsae* sp. nov. A, B, D, female holotype, G–I, female paratype, (AM P41342), remainder as indicated. A, lateral view; B, dorsal view; C, frons and anterior of head in ventral view; D, pleon and pleotelson, ventral view; E, head and anterior pereonites, female 3.5 mm Flinders I. (NMV J39716); F, head and anterior pereonites, male 2.8 mm paratype (AM P41342); G, antennule; H, antennule, detail of marginal setae; I, antenna.

appearing rounded in lateral view, inferior margin with setulose fringe and CP setae; propodus 2.8 times as long as proximal width, tapering distally, inferior margin with fringe of CP setae, superior margin with numerous scale-setae; dactylus 0.7 times as long as propodus.

Pleopod 1 exopod and endopod with 13 and 8 PMS respectively; endopod 0.8 times as long as exopod, slender, 4 times as long as greatest width, proximal lateral margin weakly concave. Pleopod 2 exopod and endopod with 16 and 10 PMS respectively, those of the proximal two-thirds of the exopod lateral margin only feebly plumose; endopod 1.8 times as long as exopod. Pleopod 3 exopod and endopod with c. 17 and 8 PMS respectively. Pleopod 4 both rami with prominent ridges, exopod lateral 0margin with 4 fine setae. Pleopod 5 both rami with

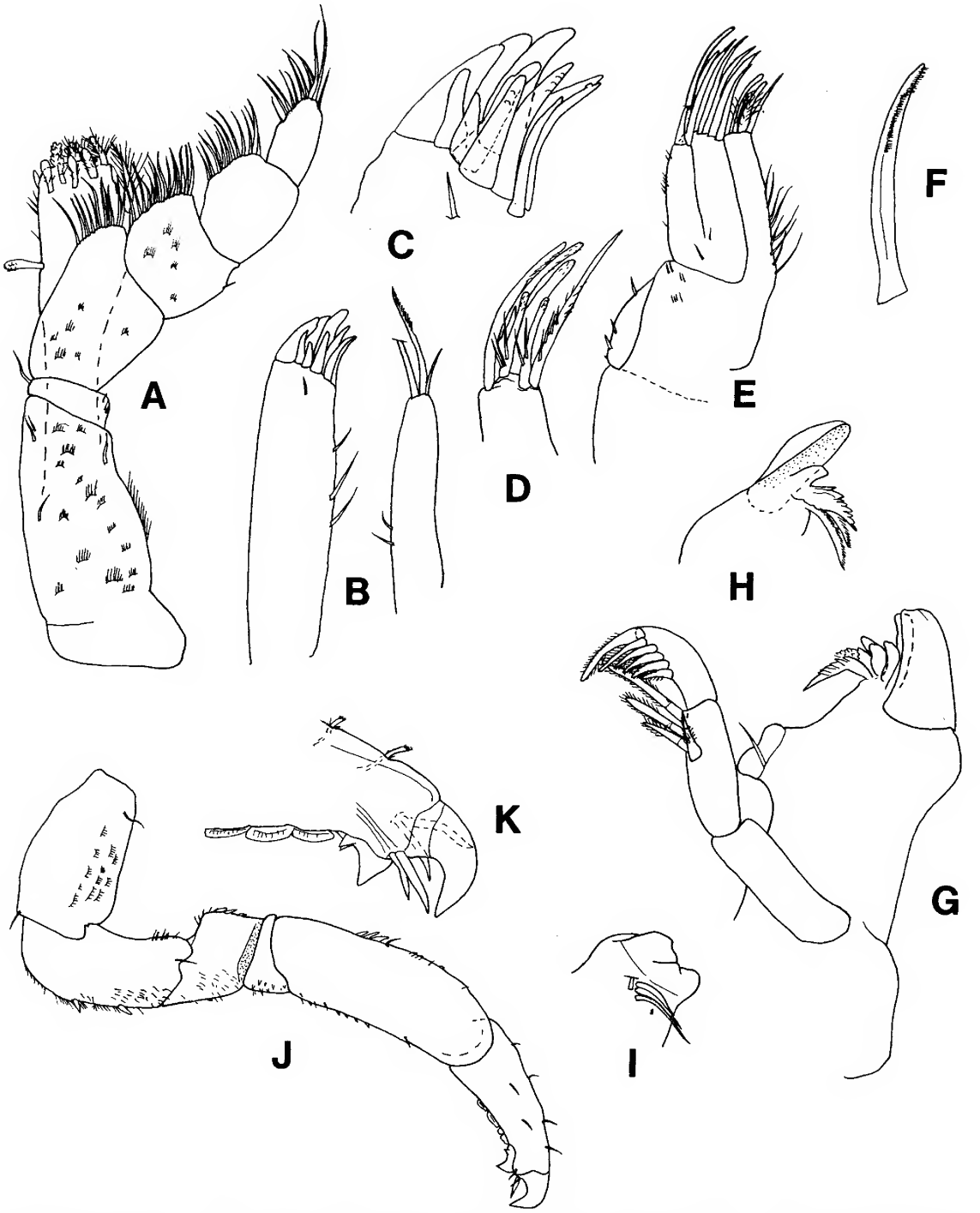

Figure 2. *Austrasphaera berentsae* sp. nov. All figs female paratype (AM P41342). A, maxilliped; B, maxillule, mesial and lateral lobes; C, apex, maxillule lateral lobe; D, maxilla mesial lobe apex; E, maxilla; F, robust setae from maxilla middle lobe; G, right mandible; H, distal left mandible; I, mandible molar; J, pereopod 1; K, pereopod 1, dactylus unguis and secondary unguis.

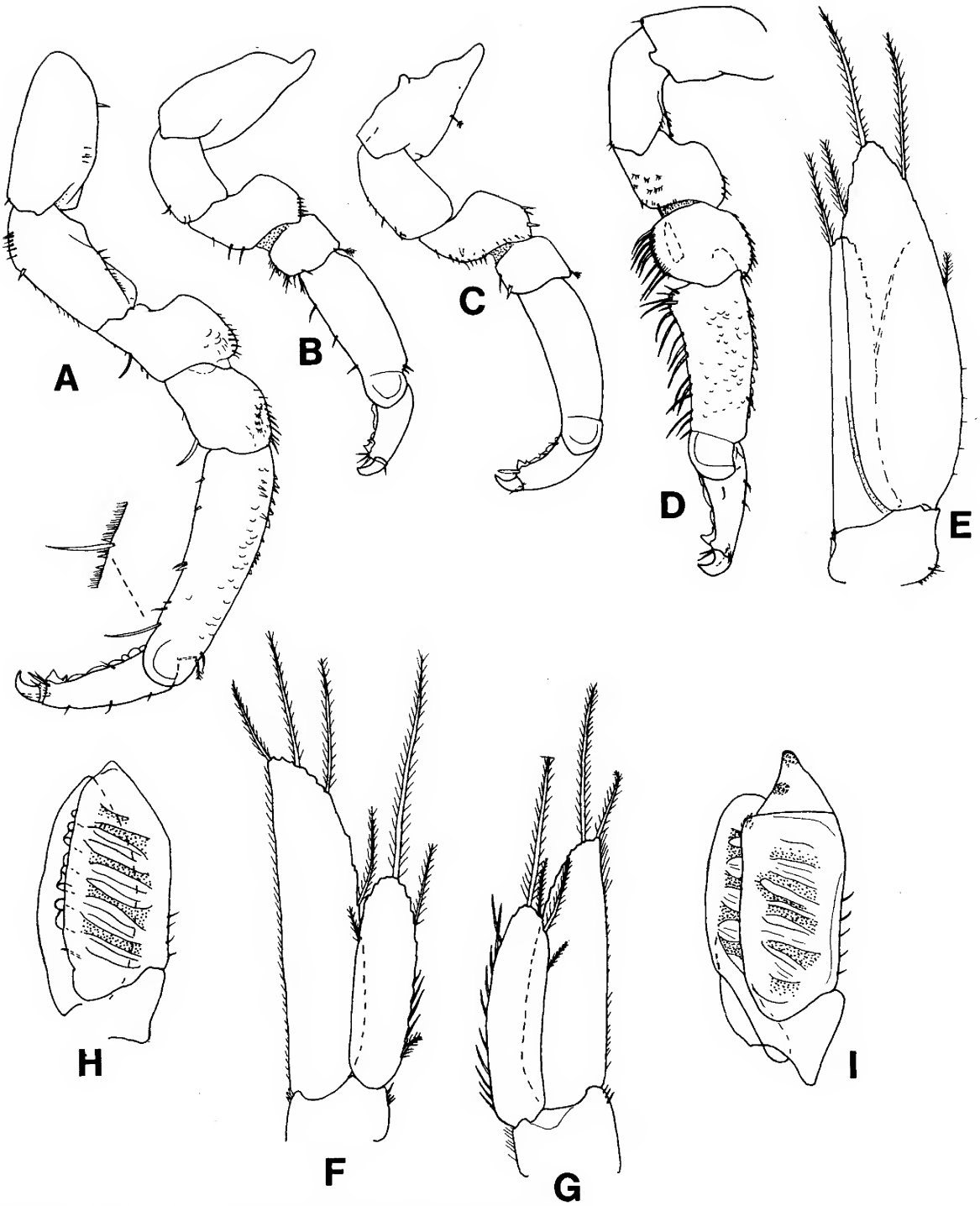

Figure 3. *Austrasphaera berentsae* sp. nov. A–D, pereopods 2, 3, 6 and 7; E–I, pleopods 1–5.

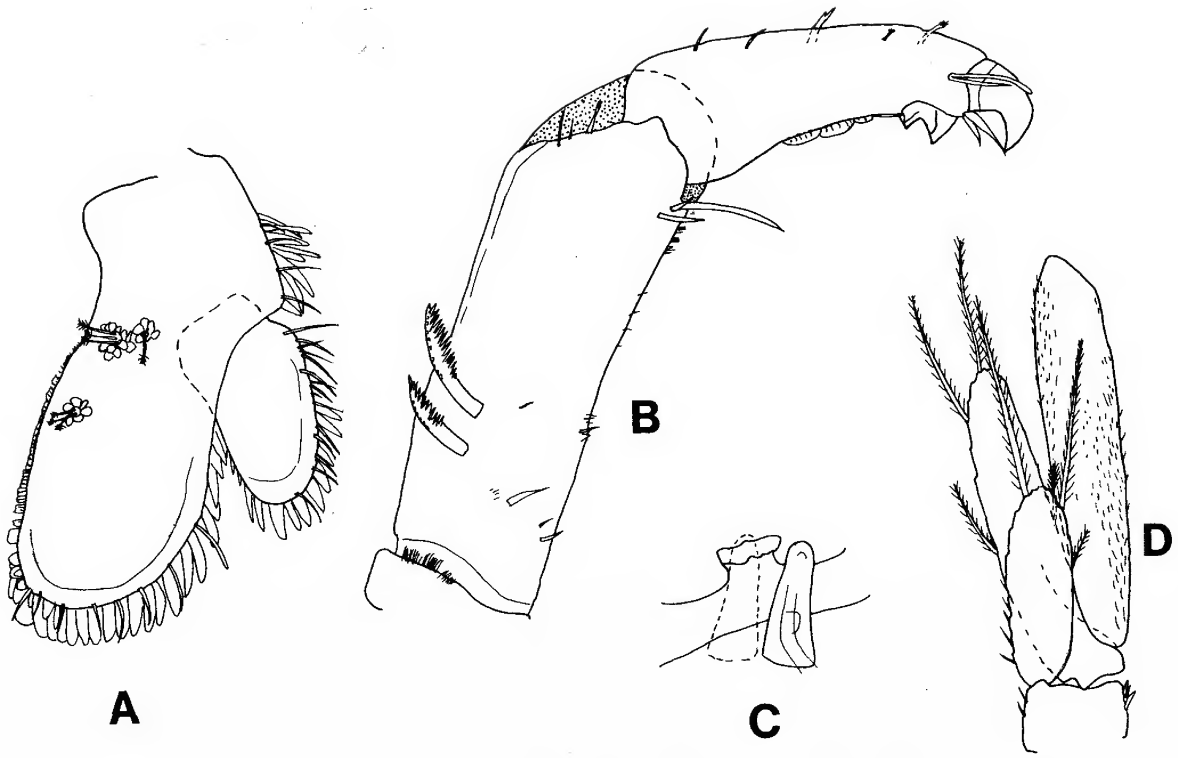

Figure 4. *Austrasphaera berentsae* sp. nov. A, uropod, female paratype (AM P41342). B–D, male NMV J26391). B, male pereopod 1; C, penial process and pleonal sternite; D, pleopod 2.

prominent ridges; exopod with 3 scale patches and transverse suture. Uropod rami flattened, margins provided with continuous flattened scales and fine setae; exopod 0.4 times as long as fused endopod, 1.8 times as long as greatest width, distal margin broadly rounded; endopod broadly rounded, dorsal with 3 clusters of sensory setae.

Male. Anterior margin of head produced slightly dorsally (in contrast to female in which is produced anteriorly). Males lack indistinct nodules on pereonite 1, pleon and pleotelson. Pereopod 1 propodus proximomesial surface with 2 strongly pectinate robust submarginal setae. Penial processes separate, adjacent, about 2.5 times as long as basal width, tapering to rounded apex. Pleopod 2 endopod 1.7 times as long as exopod; appendix masculina lateral margins diverging slightly, surface with abundant microtrichs, about 5.3 times as long as wide, and 1.2 times as long as endopod, apex obliquely truncate; widest at approximately three-quarters of its length.

Size. Males 2.1–2.8 mm, ovigerous females 3.5–3.8 mm, non-ovigerous females 3.2–3.6 mm.

Etymology. For Dr Penny B. Berents (Australian Museum), amphipod taxonomist and collector of much valuable peracarid material.

Distribution. Vic., SA, WA, north to Kalbarri; 2.5–23 m, with red and brown algae, including the red alga *Laurencia* and the seagrass *Posidonia*.

Remarks. Austrasphaera berentsae is readily distinguished by the head being strongly produced anteriorly, an ovate body shape, the uropods being posterolateral in position and not meeting posteriorly and by the short uropod exopod. The uropods of the sympatric *A. springthorpei* fold across the posterior margin of the pleotelson, and the penial processes are relatively shorter and the appendix masculina less massive than that of *A. berentsae*.

Austrasphaera springthorpei sp. nov.

Figures 5–7

Material examined. Holotype. Female (ovigerous 3.2 mm), WA, Red Bluff, Kalbarri, 27°42′S, 114°0.9′E, 10 Jan 1984, mixed corallines, R.T. Springthorpe (AM P51057).

Paratypes. 10 males (2.2–2.5 mm), 17 females (with visible ova 2.5–3.5 dissected, 3.5, non-ovigerous 2.4–3.3 mm), c. 64 unmeasured male, female, and mancas, same data as holotype (AM P41124). Male (2.4 mm), female (ovigerous 3.0 mm), same data as holotype except mixed algae and sediment (AM P41128). 2 males (2.4, 2.5 mm), female (2.5 mm), Point Peron, 48 km S of Perth, 32°16′S, 115°41′E, 27 Jan 1972, 4 m, *Posidonia* and algae, W.F. and J.M. Ponder (AM P51060). 2 females (ovigerous 2.7, 2.9 mm), Mississippi Bay, 48 km E of Esperance, 34°0.0′S, 122°170′E, ?1972, 2 m, mixed algae, W.F. and J.M. Ponder (AM P51058).

Non-type material. **Vic.** Henty Reef, Apollo Bay, Mounts Bay, 38°47.0′S, 143°40.5′E, 18 m, red algae on boulder (AM P51059). **SA.** W of "The Hotspot" reef, Flinders I., 33°40.8′S, 134°22.5′E, 21 m,

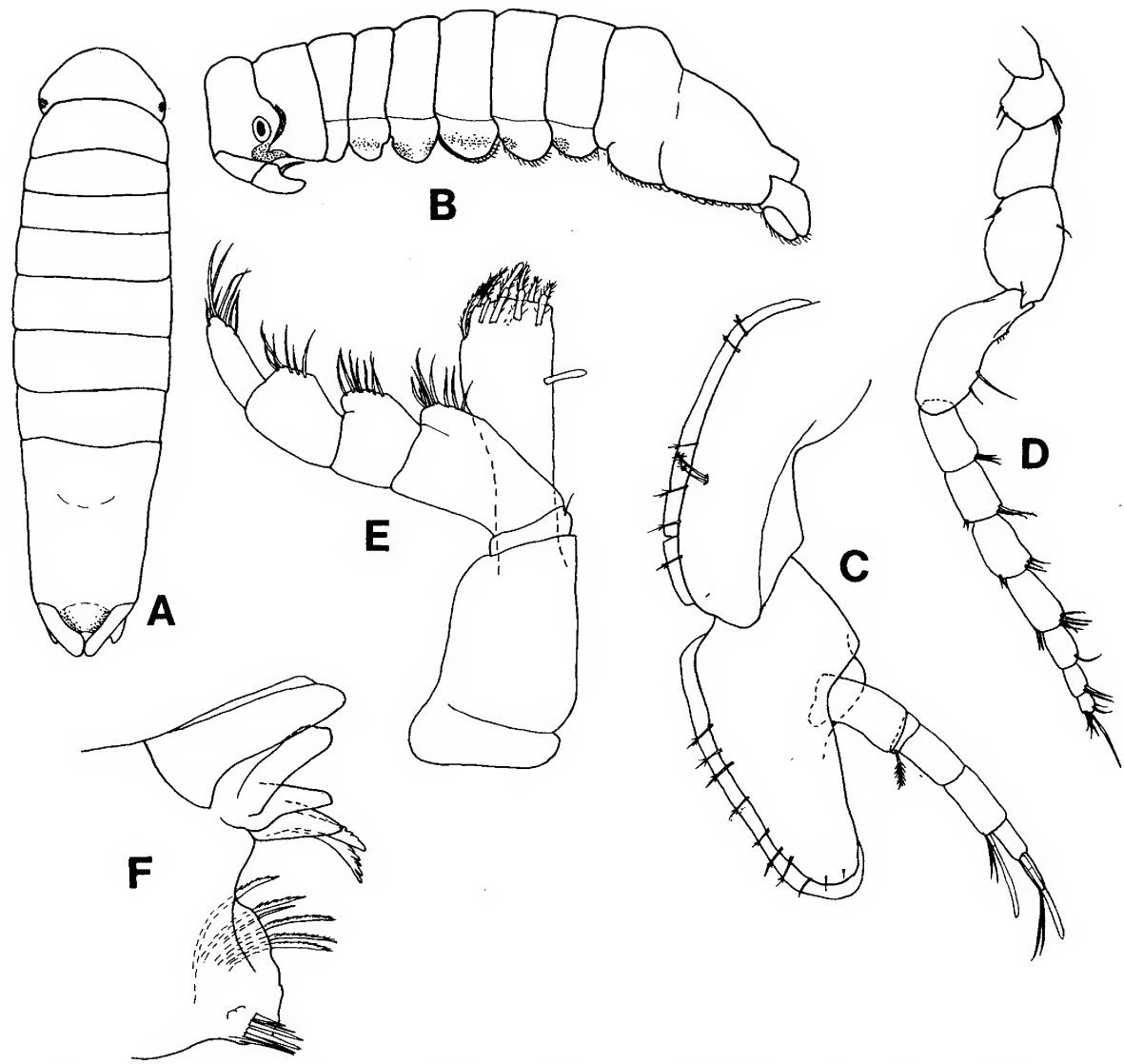

Figure 5. *Austrasphaera springthorpei* sp. nov. A, B, holotype, remainder female paratype (AM P41124). A, dorsal view; B, lateral view; C, antennule; D, antenna; E, maxilliped; F, left mandible.

large red algae (NMV J39699); 17 m, assorted algae (NMV J39726); 21 m, large red algae (NMV J39718). North of Tiparra Light, Tiparra reef, 34°4′S, 137°23′E, 10 m, red algae (NMV J26209). WA. Dongara (NMV J39725).

Description of female. Body about 3.8 times as long as greatest width, ovate, widest at pereonites 5 and 6; dorsal surfaces smooth, without setae or microtrichs. Cephalon anterior margin without transverse ridge, ventral rostral process weakly developed. Head and pereonites 1 subequal in length in dorsal view, pereonite 1 about 1.2 times as long as pereonite 2; pereonites 2–7 of approximately equal length, 5 and 6 slightly longer than 7 and 4; coxae with sutures, ventrally directed, inferior margins with setulose fringe. Pleon mesial portion indistinctly raised, posterior margin indicated short lateral suture. Pleotelson posterior margin depressed, terminally with minute indentation, forming open exit-channel with uropods; ventral margin with shallow exit channel not extending to posterior of pleotelson.

Antennule peduncle article 2 1.6 times as long as wide, about 0.9 times as long as article 2; article 2 flattened, with large anterodistal lobe; anterior margins of both articles 1 and 2 with gel-like layer and fine tubular setae; article 3 about one-third as long as article 2, inserted at midpoint of posterior

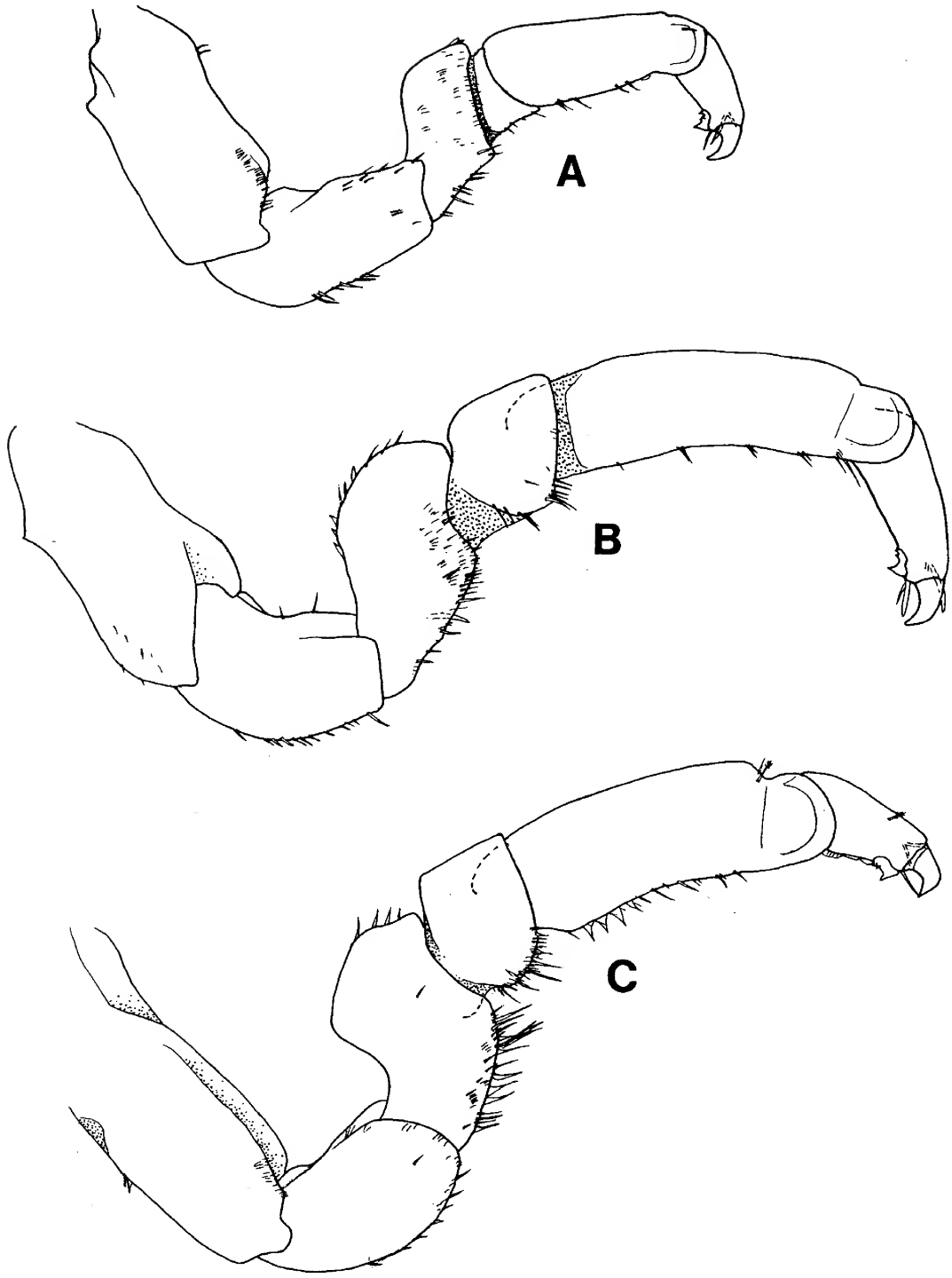

Figure 6. *Austrasphaera springthorpei* sp. nov. Female paratype (AM P41124). A–C, pereopods 1, 2, and 7.

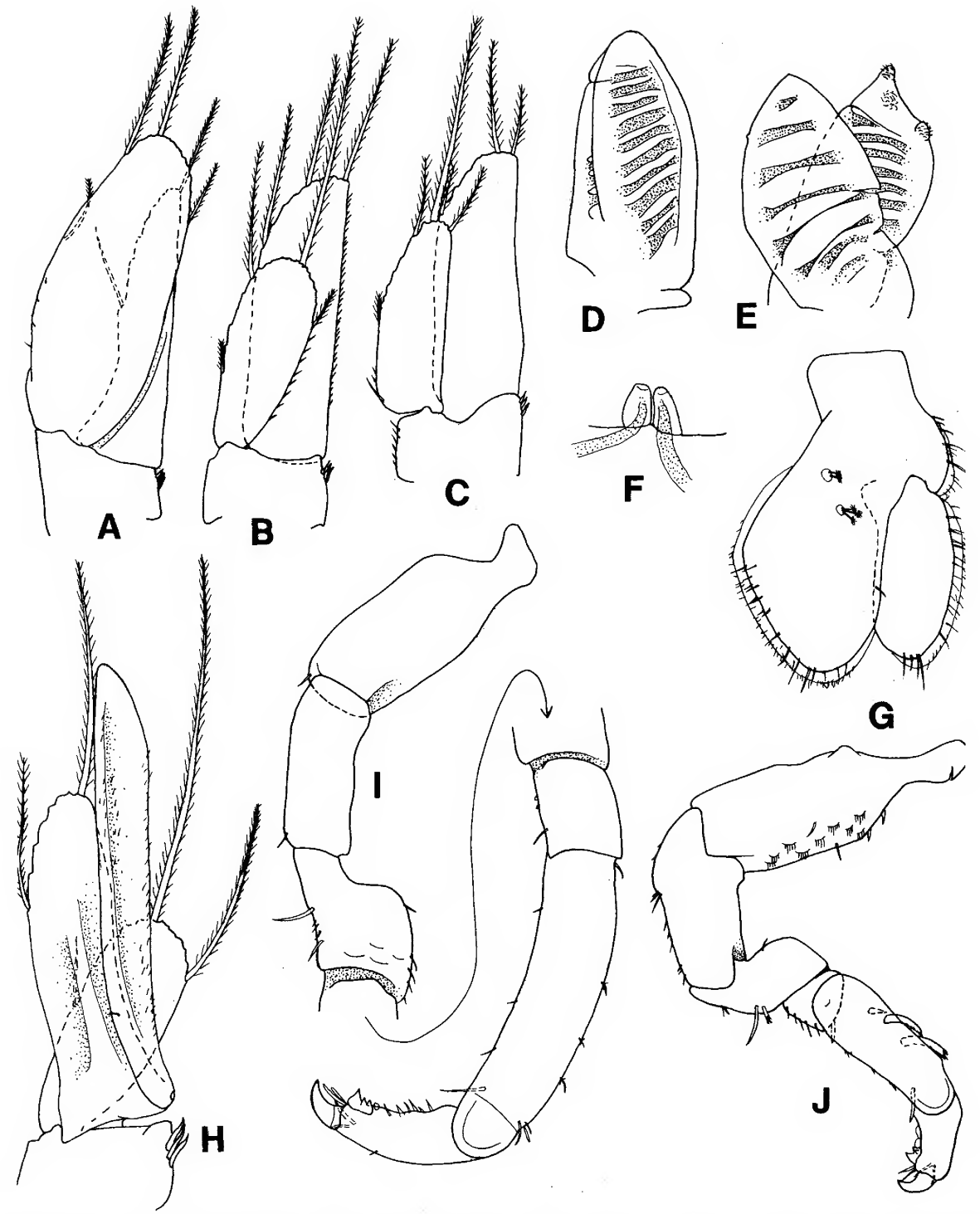

Figure 7. *Austrasphaera springthorpei* sp. nov. A–E, G, female paratype, F, H–J male paratype (AM P41124), A–E, pleopods 1–5; F, penial processes; G, uropod; H, pleopod 2, male; I, pereopod 2, male; J, pereopod 1 male.

margin; flagellum 3-articled, extending to pereonite 1, about 1.7 times as long article 3. Antenna peduncle articles 1–3 short, combined lengths about equal to that of article 5; articles 4 and 5 subequal in length; flagellum about 0.7 as long as peduncle, extending to anterior margin of pereonite 2, with 7 articles.

Epistome and mouthparts conforming to the generic characters and generally similar to that of *A. berentsae.* Maxilliped palp articles 2–5 mesial margins with 7, 7, 6 and 8 setae respectively.

Pereopods similar to *A. berentsae.*

Pleopod 1 exopod and endopod with 18 and 10 PMS respectively; endopod 0.9 times as long as exopod, slender, 3.3 times as long as greatest width, proximal lateral margin distinctly concave. Pleopod 2 exopod and endopod with 18 and 9 PMS respectively; endopod 1.4 times as long as exopod. Pleopod 3 exopod and endopod with 10 and 8 PMS respectively. Pleopod 4 and 5 with both rami with prominent ridges, both with incomplete transverse suture; pleopod 5 exopod with 3 scale patches. Uropod rami flattened, margins provided with gel-like layer and fine setae; exopod 0.6 times as long as fused endopod ovate, twice as long as greatest width, distal margin broadly rounded; endopod broadly rounded, mesial margin oblique to lateral margin, dorsally with 2 clusters of sensory setae.

Male. Penial processes about 1.3 times as long as basal width, tapering to rounded apex. Pleopod 2 endopod 1.3 times as long as exopod; appendix masculina weakly sinuate, mesial margin curving laterally slightly, surface with scattered microtrichs, about 8.6 times as long as wide, 1.4 times as long and 0.6 times as wide as endopod, apex narrowly rounded.

Size. Males 2.2–2.6 mm, ovigerous females 2.5–3.5 mm, non-ovigerous females 2.4–3.3 mm.

Etymology. For Roger T. Springthorpe (Australian Museum), whose field-collecting has over the years contributed many new discoveries.

Distribution. Western Vic., SA and WA to Kalbarri; 2–18 m, from coralline and red algae and *Posidonia.*

Remarks. See *Remarks* for *A. berentsae* for the differences that separate the two species of *Austrasphaera.* As the appendages of these two species are so similar an abbreviated description is given for this species.

Cassidias Richardson

Cassidias Richardson, 1906: 20.—Barnard, 1920: 374.—Kensley, 1978: 87.—Harrison, 1984a: 373.—Harrison and Ellis, 1991: 934.

Type species. Cassidias argentinea Richardson, 1906, by monotypy. Types held at USNM, Smithsonian Institution, Washington, DC, USA.

Diagnosis. Pleotelson with prominent median process; posterior margin with simple median notch and distinct ventral exit channel. Antennule peduncle article 1 more than twice as long as article 2, articles 1 and 2 robust; article 3 slender, all articles collinear. Maxilliped palp articles 2–4 with distomesial angle moderately produced, mesial margins with numerous setae. Pleopods 1–3 with both rami longitudinally oblique. Pleopod 2 with appendix masculina distally attached. Male uropods attached subdistally on pleon, endopod reduced to short stub, exopod round in section with apical spike, entire ramus extending beyond posterior margin of pleotelson.

Description of male. Body stout, about twice as long as greatest width, strongly vaulted; dorsal surface finely granular, with scattered setae; unable to conglobate. Head weakly immersed in pereonite 1. Eyes large, lateral, facets distinct, prominent posterior lobe. Pereon segments without raised posterior margins. Coxae not distinctly demarcated, overlapping anterior over posterior, ventrally directed. Membrana cingula absent. Pleon of 4 segments, segment 1 largely concealed by pereonite 7, segments 2–4 indicated by 2 distinct suture lines running to lateral margins of pleon. Pleotelson with prominent median process; posterior margin with simple median notch and distinct ventral exit channel. Pleonal sternite present.

Antennule and antenna anteriorly positioned on head. Antennule peduncle articles 1 and 2 robust, article 1 more than twice as long as article 2; article 3 slender, all articles collinear; flagellum shorter than peduncle, extending to anterior of pereonite 1. Antenna peduncle article 1 and 2 short, subequal, shorter than 3–5, which become progressively longer; flagellum about as long as peduncle, extending to posterior of pereonite 1.

Epistome anteriorly acute, with weak mesial constriction; with indistinct ventral tubercle Labrum unornamented. Mandible incisor multicuspid; molar process prominent, crushing, provided with marginal scale teeth; left mandible with prominent lacinia mobilis both mandibles with spine row of 5 or 6 spines; palp article 1 longest, 3 shortest. Maxillule lateral lobe with about 13 RS on gnathal surface, most of which are serrate; mesial lobe with 5 long RS, 3 of which are prominently serrate. Maxilla with all articles well developed; lateral and middle lobes with flat strongly curved and finely serrate RS, mesial lobe with several and acute long RS, some of which are basally CP. Maxilliped endite distal margin numerous long acute CP setae and 3 long CP RS on distomesial margin; palp articles 2–4 each with distomesial angle produced, mesial margins with numerous setae, lateral margins of articles 2 and 3 without setae, article 4 with 1 seta.

Pereopods all ambulatory, pereopods 1–3 subsimilar, more robust than 4–7; inferior margins of merus, carpus and propodus with serrate and CP RS; setulose fringe weakly developed; dactylus with prominent simple secondary unguis and 1 flattened seta arising at lateral margin, 2 flat setae at distolateral margin. Pereopods 6 and 7 inferior and distal margins of merus, carpus and propodus with numerous serrate and biserrate RS.

Penes paired, separated by about basal width of penial process; short, not reaching pleopod peduncles.

Pleopods 1–3 both rami with PMS, longitudinal axis of both rami oblique Pleopod 1 exopod extending beyond endopod distal margin subtruncate, proximolateral angle with single short acute RS; endopod distinctly triangular in shape. Pleopod 2 with appendix masculina distally attached on mesial margin. Pleopod 3 exopod with complete suture, suture not distinct on pleopod 4 and incomplete on pleopod 5. Pleopods 4 and 5 exopod and endopods with well-developed transverse thickened ridges; pleopod 5 endopod with 3 lobate scale patches and

transverse suture. Uropod exopod 3 times as long as wide, subdistally attached on pleon, endopod reduced to short stub, exopod round in section with apical spike, entire ramus extending beyond posterior margin of pleotelson.

Female. Pleotelsonic process considerably smaller than in the male; uropods with both rami lamellar, positioned midlaterally on pleon, endopod extending only slightly beyond posterior margin of pleotelson; both rami with numerous CP setae. Mouthparts metamorphosed. Brood pouch of the type species made up of 4 pairs of oostegites on pereonites 1–4 (Harrison 1984, but see remarks).

Composition. Cassidias argentinea Richardson, 1906, *C. australiensis* sp. nov., *C. africana* Barnard, 1920. *Cassidias tritubercula* Thielemann, 1910 has been synonymised with *Holotelson tuberculatus* Richardson, 1909 (Kwon, 1990).

Remarks. Harrison (1984a), on the basis of differences in brood-pouch morphology, excluded *Cassidias africana* Barnard, 1920 from the genus. The type species is known only from females (Richardson, 1906), and until such time as males are known it is impossible to assess the generic characters for this genus. Although brood-pouch morphology is generally consistent within sphaeromatid genera, there is insufficient evidence to consider such differences to be axiomatically of generic merit, and this character is known to vary in *Sphaeroma* (Harrison, 1984a) and now also in *Margueritta* (present study). At present it seems appropriate to retain the genus, diagnosed on the basis of the known males, with recognition that its status is uncertain. A new genus cannot adequately be differentiated from *Cassidias* on the basis of type material.

Males of this genus, as here defined can be readily recognised by subterminal uropods which have the endopod reduced in size, by the presence of a broad, blunt, posteriorly directed process on the pleotelson and by the terminal appendix masculina. In addition, the posterior margin of the pleotelson has a distinct simple median notch. Females have the uropods in a more midlateral position and both rami are flat. The process on the pleotelson is reduced compared with that of the male, but does allow identification of females.

The most similar genus is *Neonaesa* Harrison and Holdich, 1982b which is readily differentiated by the males having the appendix masculina mesially attached, the pleotelson posterior margin with three small notches and the pleotelson dorsal surface with a small median boss flanked by two low submedian bosses. Females of *Neonaesa* are separated by having a cylindrical uropodal exopod and a reduced endopod in contrast to female *Cassidias* which have uropodal rami both present and flat.

Cassidias australiensis sp. nov.

Figures 8–13

Material examined. Holotype. Male (4.0 mm), NW end of McCluer I., **NT,** 11°02′S, 132°58′E, 16 Oct 1982, hydroids etc. from bommies, G.C.B. Poore (NMV J39703).

Paratypes. **NT.** Males (3.4–4.0 dissected, 4 each 3.5–4.0 [all crushed] mm), females (ovigerous 4.3 mm, dissected, non-ovigerous 2.6–4.2 dissected), immature (2.3–2.7 mm), 54 unmeasured immature, males and females, same data as holotype (NMV J26384, J39709). Female (non-ovigerous 3.2 mm), Table Head, Coburg Peninsula, 11 May 1983, mixed substrata, rocks and sponges, N.L. Bruce (NTM Cr012315). Male, 25 females and immature, McCluer I., S end, 11°06′S, 133°00′E 17 Oct 1982, 8.0 m, hydroids etc., G.C.B. Poore (NMV J26388). 4 males, c. 40 females and immature, McCluer I., NW end, 11°02′S, 132°58′E 16 Oct 1982, 8.0 m, yellow hydroids, J.K. Lowry (NMV J26389). 13 males, c. 100 females and immature, Fannie Bay, Darwin, 11°24′S, 130°48′E , 26 Oct 1982, 8 m, hydroids etc, J.K. Lowry (NMV J26386). **WA.** Females (ovigerous 3.0, non-ovigerous 3.1 mm), North-West Shelf, 19°29.7′S, 118°52.2′E, 24 Oct 1983, 37 m, sled, CSIRO, RV Soela (WAM C28895).

Description of male. Body about twice as long as greatest width, strongly vaulted, ovate, widest at pereonite 5; dorsal surfaces anteriorly smooth, becoming minutely granular towards posterior, scattered setae present on posterior of pereonites and on pleotelsonic process. Cephalon anterior margin with 2 transverse ridges, ventral rostral process weakly developed. Head and pereonite 1 subequal in length in dorsal view, pereonite 1 about 1.4 times as long as pereonite 2, unornamented; pereonites 2>3<4<5>6>7. Pleon about twice as long as pereonite 7, with evident sutures and sublateral 'keys'. Pleotelson process proximal half with convex lateral margins distal portion with lateral margins straight, posteriorly subtruncate with weak median indentation; distal part with 2 distinct ranks of setae merging to one across posterior margin; in lateral view appearing distally narrowly rounded; ventral margin with deep exit channel, ventral margin wide and flattened with sublateral depression mesial to uropods.

Antennule peduncle article 1 1.9 times as long as wide, about 4.7 times as long as article 2, distal one-third of anterior margin with obscurely indented blade; both articles 1 and 2 finely pilose, posterior margin with sensory setae; article 3 about half as long as article 1 4 times as long as wide, twice as long as article 2; flagellum 7-articled, extending to posterior of pereonite 1, about 2.5 times as long article 3. Antenna peduncle articles 1 and 2 short, article 1 anterior margin with mass of setae, combined lengths about equal to that of article 5; article 3 about 0.8 times as long as article 4; article 4 about 0.7 as long as article 5, articles 3–5 collinear; flagellum about equal in length to peduncle, extending to anterior margin of pereonite 2, with 12 articles.

Epistome anteriorly acute, minutely granular, with weak lateral constriction; with distinct anteromedial nodule. Left mandible incisor with 4 cusps, lacinia mobilis with 3 cusps, spine row of 5 serrate curved spines; right mandible with 3 indistinct cusps, spine row of 2 broad-based multidigitate spines, 5 serrate spines; molar process round; palp articles 1 and 2 subequal in length, article 2 distolateral margin with 3 biserrate setae; article 3 with 11 biserrate setae, terminal seta being largest. Maxillule mesial lobe with 3 long, weakly pectinate RS and 2 shorter simple RS, lateral lobe with 11 peripheral RS on gnathal surface, twelfth seta set between these; most RS are weakly and bluntly serrate on distal part, proximal RS strongly serrate. Maxilla lateral lobe and middle lobe each with 7 and 6 curved finely serrate RS respectively, mesial lobe with 6 serrate and biserrate RS. Maxilliped endite lateral margin strongly convex, distal margin with 1 simple RS at sublateral angle, 4 curved CP RS, 3 sinuate CP RS; distomesial margin with 3 large stout CP RS, increasing in size proximally;

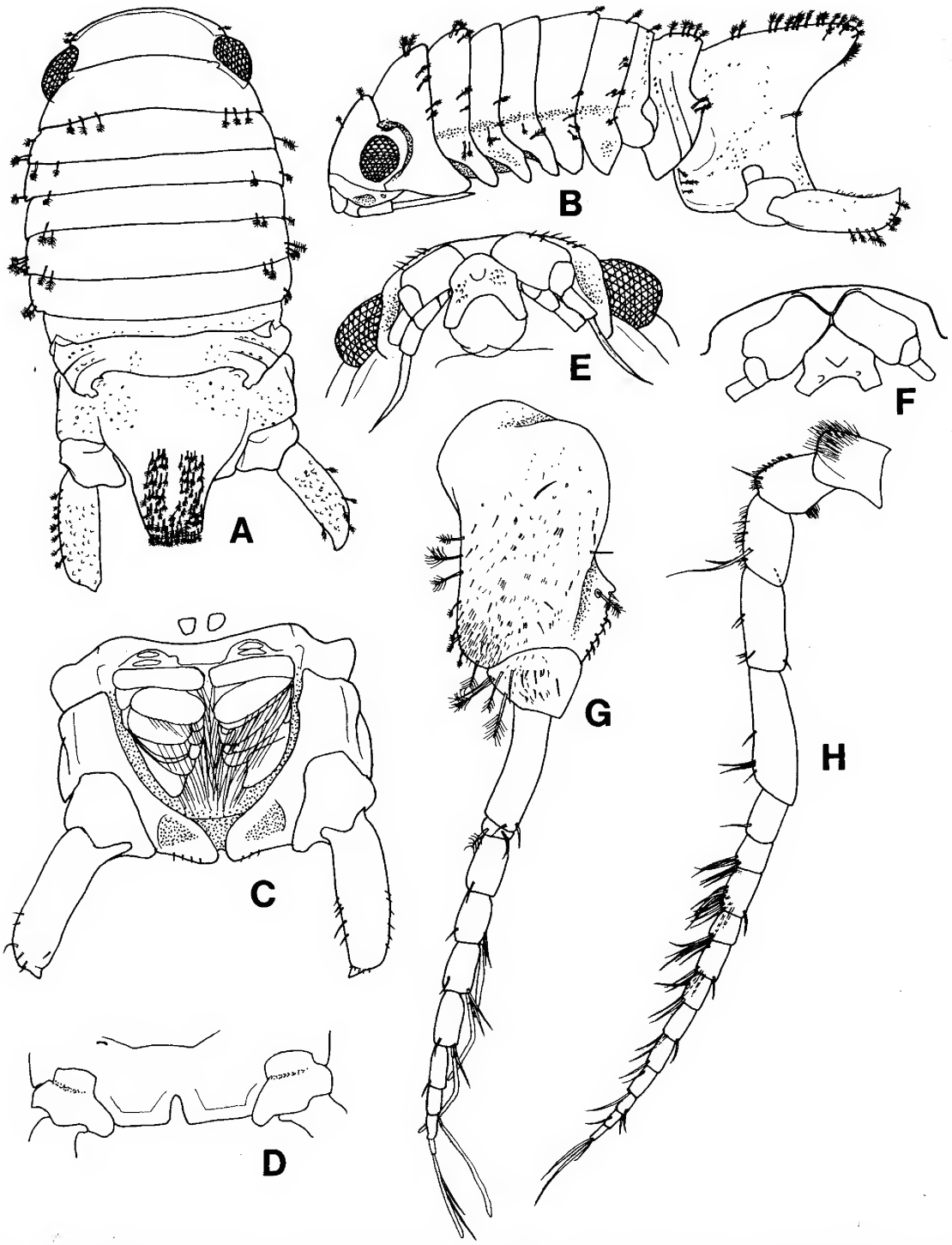

Figure 8. *Cassidias australiensis* sp. nov. A–F, male holotype, G–H, male paratype, remainder as indicated. A, dorsal view; B, lateral view; C, pleon, ventral view; D, pleotelson, posterior margin, posterior view; E, frons and anterior of head in ventral view; F, frons, female; G, antennule; H, antenna.

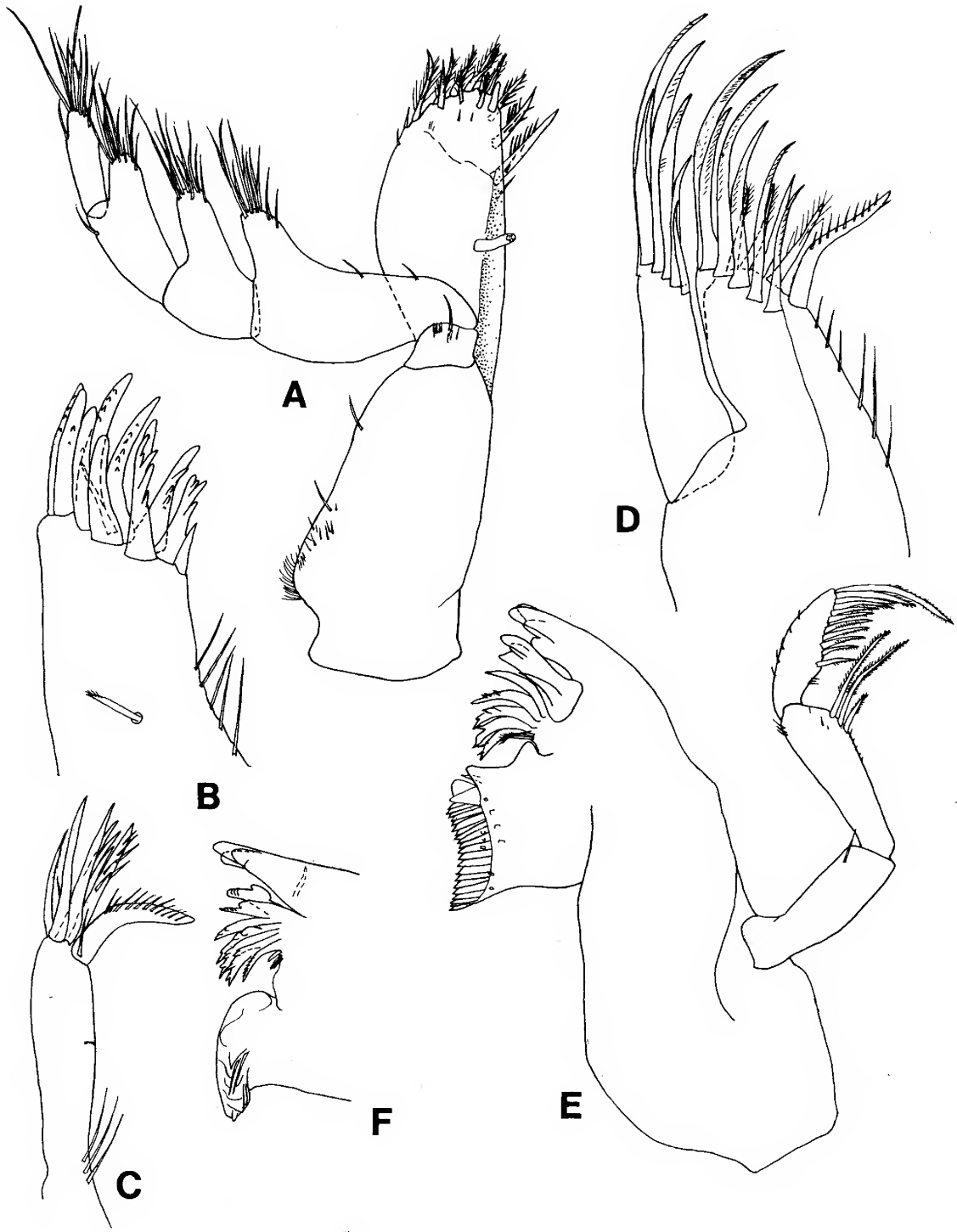

Figure 9. *Cassidias australiensis* sp. nov. All figs male paratype. A, maxilliped; B, maxillule, lateral lobe; C, maxillule mesial lobe; D, maxilla; E, left mandible; F, right mandible, distal part.

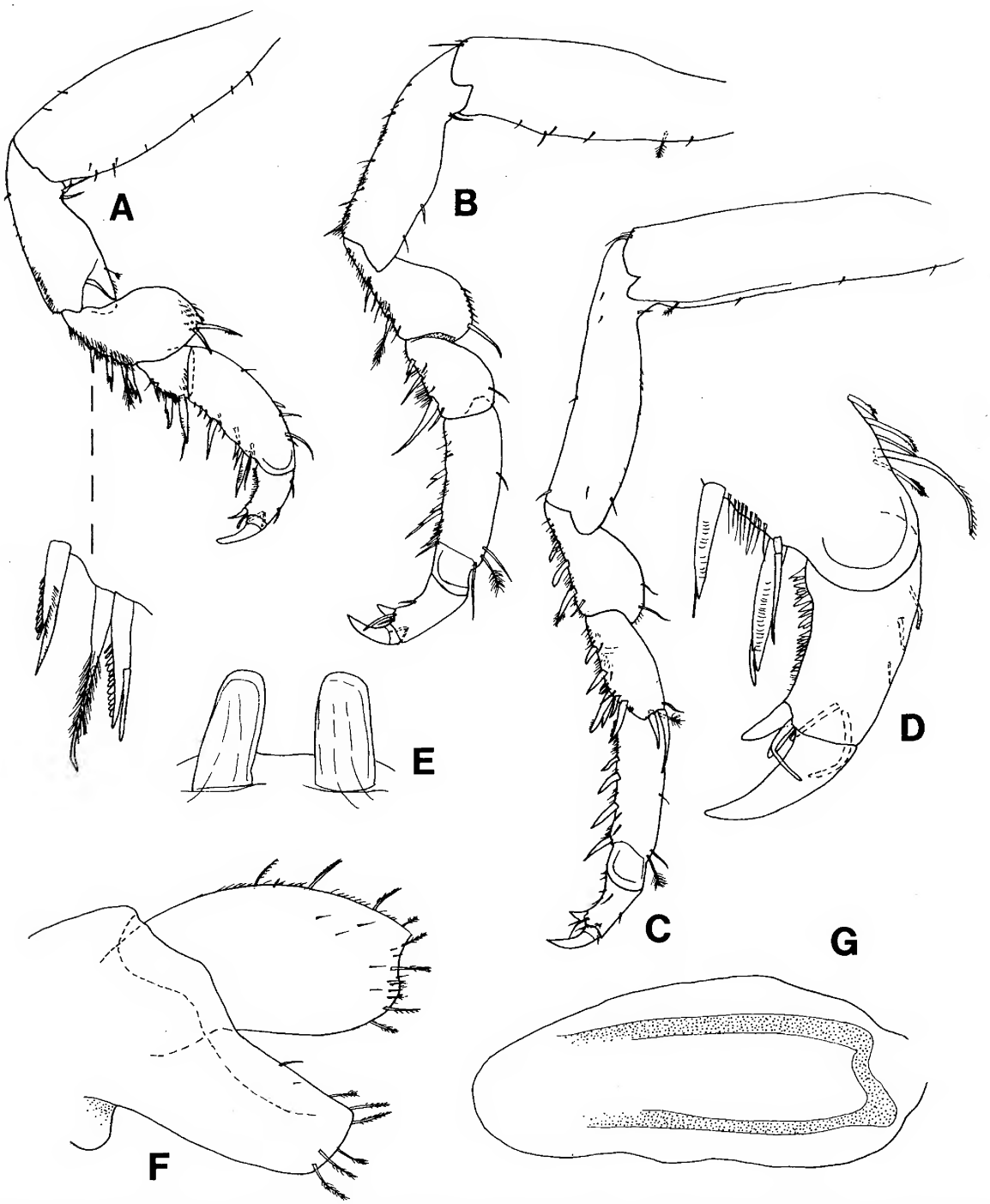

Figure 10. *Cassidias australiensis* sp. nov. A–C, pereopods 1, 2 and 7; D, dactylus, pereopod 1; E, penial processes; F, uropod, immature; G, oostegite 2 .

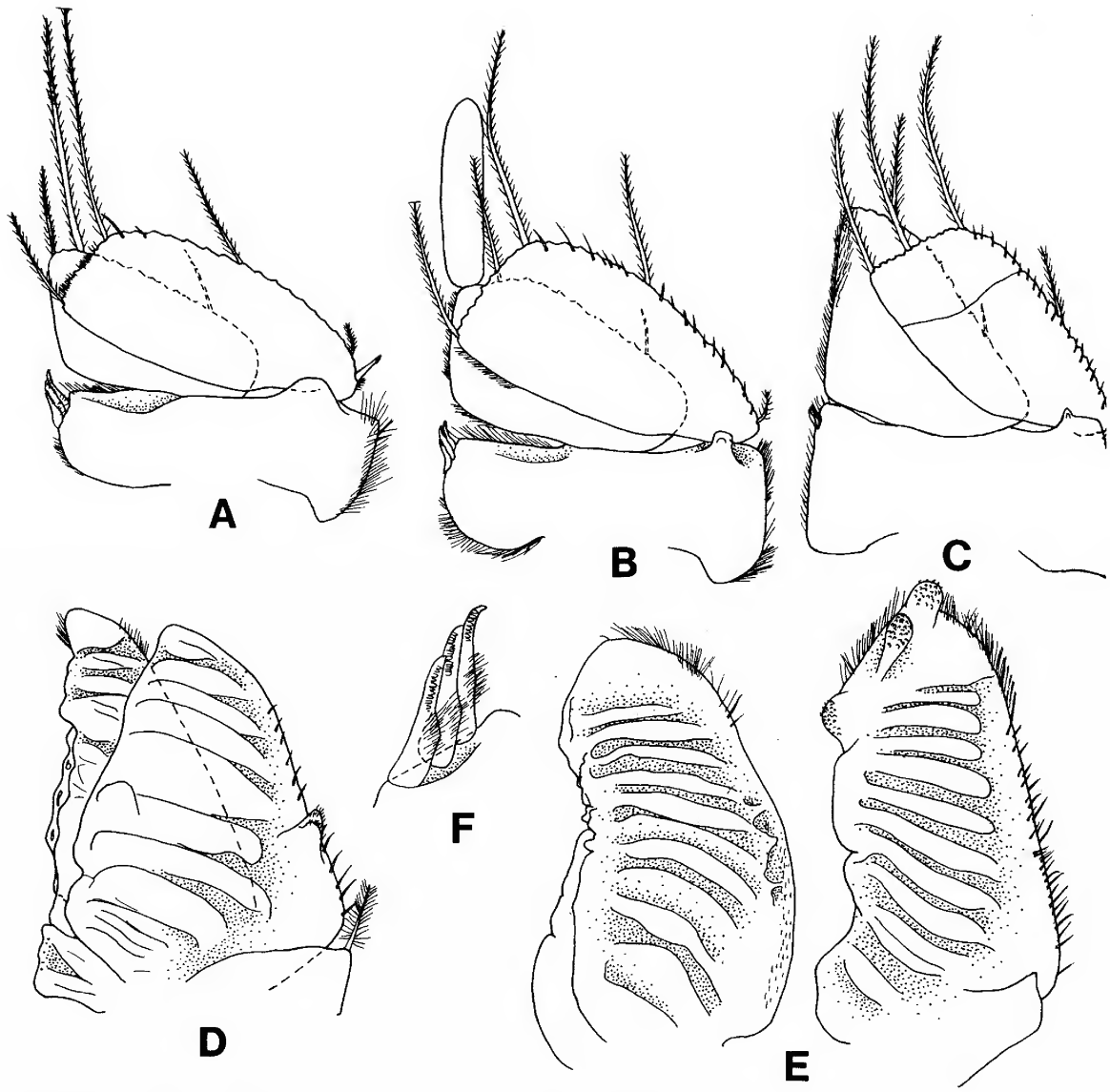

Figure 11. *Cassidias australiensis* sp. nov. A–E, pleopods 1–5; F, coupling hooks, pleopod 1.

palp slender, article 2 4 times as long as basal width; articles 3 and 4 with finger-like distomesial lobes; articles 2–5 with about 12, 13, 14 and 16 setae respectively.

Pereopod 1 basis about 2.9 times as long as greatest width, approximately twice as long as propodus; superior margin with few widely-spaced short simple setae; ischium about as long as propodus, twice as long as greatest width, proximal superior margin with 2 acute short simple RS, inferior margin with short setulose fringe; merus about 0.7 as long as ischium, 1.2 times as long as greatest width, superior distal angle with 2 acute biserrate RS, inferior margin with distally plumose setae set among setulose fringe; carpus approximately as long as wide, inferior margin 0.6 times as long as merus, with 2 distally plumose setae; propodus 2.5 times as long as greatest width, inferior margin with 3 stout serrate and 2 slender distally plumose setae; dactylus 0.6 times as long as propodus, unguis inferior margin with prominent serrate cuticular scales, secondary unguis recurved simple. Pereopods 2–7 subsimilar. Pereopods 2 and 3 similar to pereopod 1. Pereopod 2 basis 3 times as long as greatest width, inferodistal angle with single simple seta, superior margin with widely spaced small setae; ischium 0.7 times as long as basis, 3 times as long as greatest width,

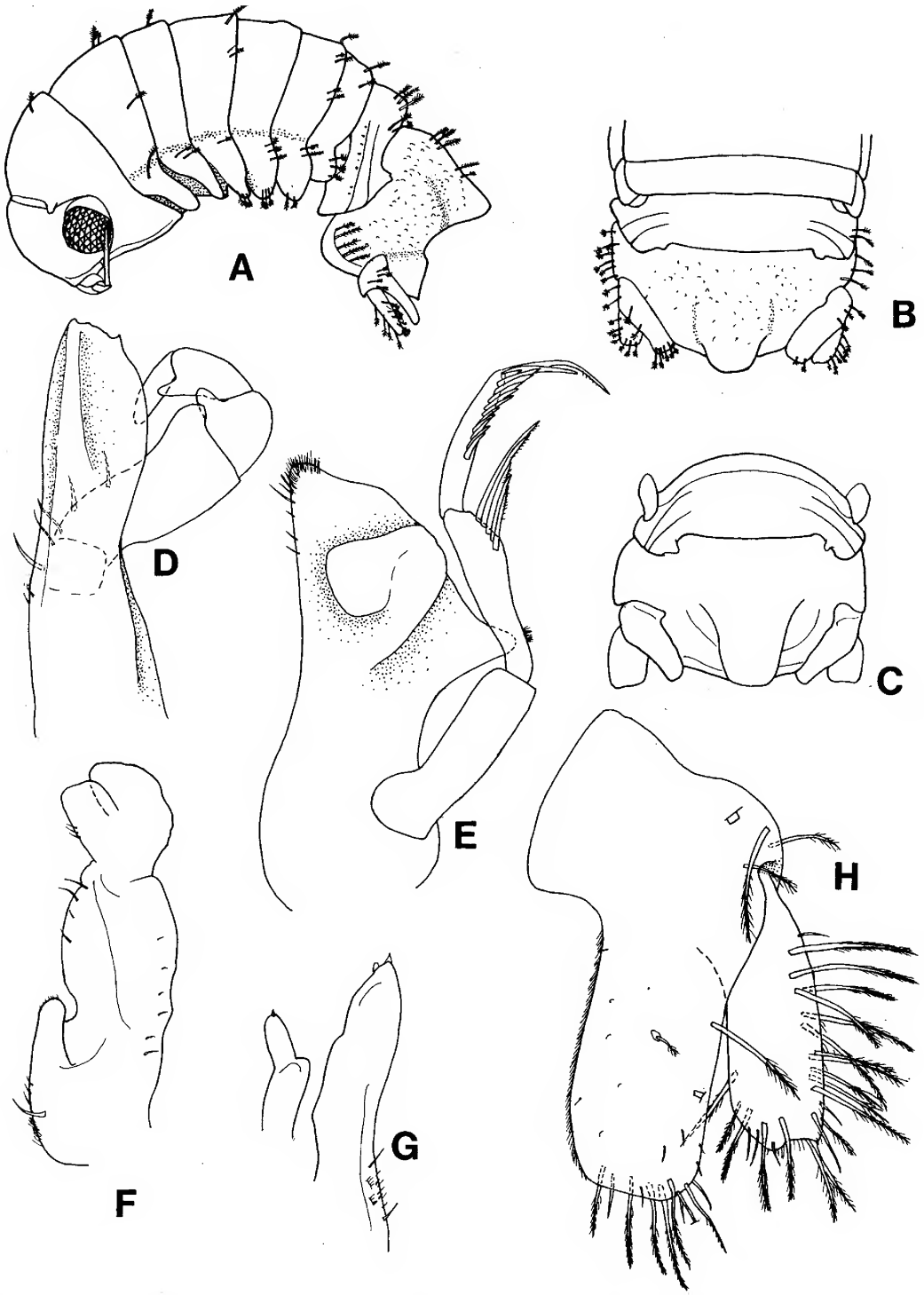

Figure 12. *Cassidias australiensis* sp. nov. All female except C, immature paratype. A, lateral view; B, dorsal view of pleon; C, dorsal view of pleon, immature; D, maxilliped; E, left mandible; F, maxilla; G, maxillule; H, uropod.

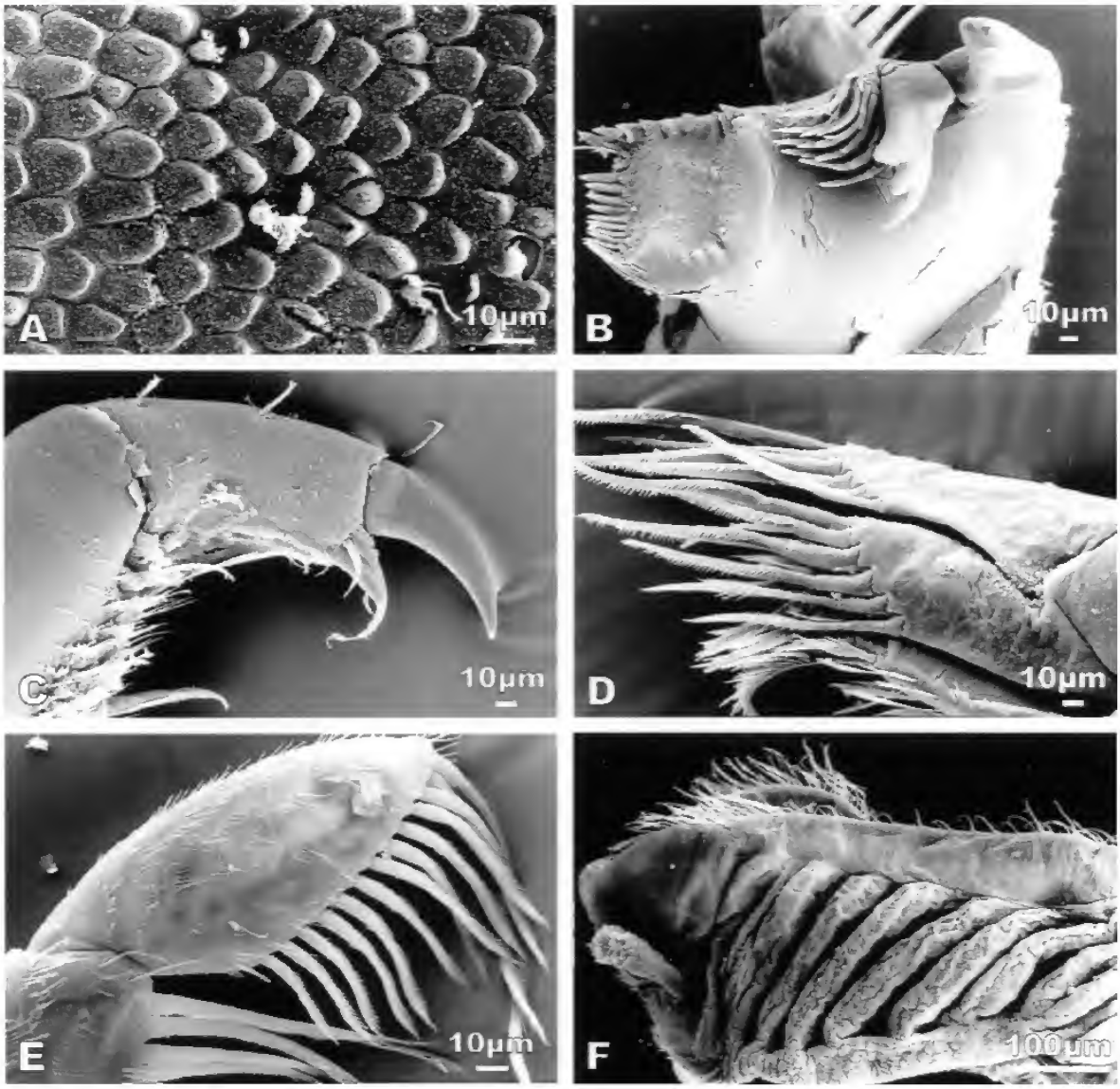

Figure 13. *Cassidias australiensis* sp. nov. SEMs. Male, McLuer Island, NT, NMV J26384. A, cuticle on pleon; B, left mandible; C, pereopod 1, dactylus; D, maxilla; E, mandible palp article 3; F, pleopod 5, exopod dorsal.

superior distal margin with 2 simple setae, inferior margin with short setulose fringe and 4 widely-spaced short simple setae; merus about half as long as ischium, superior distal angle with 1 long simple seta, inferior margin setulose with 2 long distally plumose setae, distal seta being twice as long as proximal seta; carpus anterodistal angle with single small simple seta, inferior margin setulose, with 4 setae, longest of which is simple, remainder distally plumose; propodus about as long as ischium, superior distal angle with 3 setae one of which is pappose, inferior margin finely setulose, with 3 RS; dactylus 0.6 as long as propodus. Pereopods 5–7 similar, longer and with more RS than pereopods 1 and 2. Pereopod 7 basis 4 times as long as greatest width, inferodistal angle with single simple seta, superior margin with 2 widely-spaced small setae, distally with 1 palmate seta; ischium 0.8 times as long as basis, 3.8 times as long as greatest width, proximal superior margin with 1 short acute RS, superior distal margin with 1 simple setae, inferior margin with 2 widely-spaced short simple setae; merus one-third as ischium, superior distal margin with 2 simple setae, inferior margin setulose with 3 simple RS; carpus 1.3 times as long as merus, anterodistal angle with 2 acute RS, 1 simple and 1 palmate seta, simple seta, inferior margin setulose, with 1

simple and one serrate RS, inferodistal angle with 4 serrate RS; propodus 1.7 times as long as ischium, superior distal angle with 1 simple and 1 palmate seta, inferior margin finely setulose, with 4 simple RS; dactylus 0.4 as long as propodus.

Penes twice as long as basal width, distally subtruncate; separated by 1.1 times basal width of penial process.

Pleopod 1 exopod and endopod with 26 and 12 PMS respectively; endopod 0.4 as long as exopod, 4 times as long as greatest width, proximal lateral margin weakly concave. Pleopod 2 exopod and endopod with 28 and 10 PMS respectively; appendix masculina 5 times as long as wide, bluntly rounded, mesial margin straight, lateral margin weakly convex. Pleopod 3 exopod and endopod with 28 and 13 PMS respectively. Pleopod 4 both rami with prominent thick ridges, exopod lateral margin with c. 10 fine setae, small proximal submarginal lobe. Pleopod 5 both rami with prominent thick ridges; exopod with 3 scale patches distal to suture, lateral margin with numerous short simple setae, distal margins with longer scale-setae; endopod with scale-setae on distal margin only. Uropod 3 times as long as wide.

Female. Body shape similar to that of male, but pleotelson process prominent, less developed; with fewer setae on dorsal surfaces. Uropod endopod 4 times as long as wide (including peduncular portion), distal margin subtruncate; exopod about 3 times as long as wide, distal margin concave. Brood pouch of 3 pairs of overlapping oostegites arising from pereonites 2–4.

Size. Adult males 3.4–4.0 mm, ovigerous females 3.0–4.3 mm, non-ovigerous females 2.6–4.2 mm.

Etymology. All species of *Cassidias* have been named after the country from which they were collected (coincidentally all starting with the letter 'a'), and I continue with that practice.

Distribution. NT, North-West Shelf, WA; 8–37 m. The species has been recorded from hydroids, while field observations suggest that it is a commensal of gorgonian 'corals'. A colour photograph shows a similar isopod from Indonesia, identified as *Cassidias* sp., on a gorgonian (Bruce, 1999).

Remarks. Neither *Cassidias argentinea* nor *Cassidias africana* have been described in detail. The male of *Cassidias argentinea* remains unknown, but the female differs from *C. australiensis* in being larger, with distally rounded uropods (in *C. australiensis* the female uropodal endopod is truncate, the exopod distally indented). Males of *Cassidias africana* differ in having the pleotelsonic process subacute rather than truncate and have a far longer uropodal endopod which is distally swollen giving a somewhat club-shaped appearance.

Exosphaeroma Stebbing

Exosphaeroma Stebbing, 1900: 553; 1902: 54 (part).—Stebbing, 1910a: 220.—Stebbing, 1910b: 428.—Hansen, 1905: 103, 118.—Richardson, 1905: 287.—Barnard, 1914: 374.—Monod, 1933: 9–20.—Menzies, 1962: 132.—Menzies and Frankenberg, 1966: 45.—Menzies and Glynn, 1968: 65.—Schultz. 1969: 131.—Hurley and Jansen, 1977: 55.—Kussakin, 1979: 398.—Harrison, 1984a: 381.—Brusca and Iverson, 1985: 26.—Jacobs, 1987: 67.—Kensley and Schotte, 1989: 229.—Harrison and Ellis, 1991: 939 (key).

Type species: Sphaeroma gigas Leach 1818, by original designation.

Diagnosis. Pereonite 7 posterior margin even or forming a mesial point, without processes; pleon and pleotelson without process. Pleonite 1 dorsal posterior margin with pair of flat and flush submedian lobes. Pleotelson posterior margin entire, ventrally excavate, without distinct exit channel. Maxilliped palp articles 2–4 mesial margin with distinct lobes. Pereopods 1–3 with inferior margins of merus–propodus densely setulose; ischium superior margin usually with cluster of long simple setae at midpoint. Penial process basally set apart, slender usually between 3–5 times as long as basal width. Pleopod 2 appendix masculina slender, basal in position, extending well beyond distal margin of ramus, apex may be glandular in appearance; pleopods 3–5 exopods with complete transverse suture; pleopods 4 and 5 exopods with or without thickened ridges or folds. Uropods with both rami prominent in dorsal view, lamellar, subequal in length, margins not serrated. Mouthparts not metamorphosed. Brood pouch (Harrison,1984) formed of four pairs of oostegites that do not overlap at the midline.

Species included and distribution. See Appendix. *Exosphaeroma* appears to be distributed world-wide, though apparently absent from the North Atlantic with those species currently known from the western Atlantic and Caribbean being incorrectly placed. Its presence in the eastern South Atlantic is uncertain as there are insufficient data from the African coast to be sure of its absence. Loyola e Silva (1979) reviewed the distribution of the genus as then composed.

Remarks. Characters which best serve to identify *Exosphaeroma* include the lamellar uropodal rami with the exopod being about as large as the endopod, with both rami lacking serrate margins, the entire posterior margin to the pleotelson which lacks a ventral exit channel, and the superior margin of the ischium of pereopods 1–3 provided with long setae. Pleopod 2 usually has the appendix masculina longer than the endopod, and the distal portion is often folded back on itself. Pleonite 1 has two flat submedian lobes forming part of the pleonite outline, a character shared with at least *Isocladus* Miers, 1976. That genus is readily separated by males having a prominent backwardly-directed process on pereonite 7.

Exosphaeroma is in critical need of revision, the most recent diagnosis being that of Kensley and Schotte (1989). A minimal diagnosis is offered here, based on those species for which the characters mentioned are described. Currently 32 species are included (Appendix), although many more species have been incorporated, and some removed, notably to *Gnorimosphaeroma* Menzies, 1954, *Harrieta* Kensley, 1987, *Ptyosphaera* Holdich and Harrison, 1983, *Thermosphaeroma* Cole and Bane, 1978, *Tholozodium* Eleftheriou, Holdich and Harrison, 1980 and also *Clianella* Boone, 1923, *Cymodoce* Leach, 1814, *Paracerceis* Hansen, 1905, *Pseudosphaeroma* Chilton, 1909, *Sphaeroma* Bosc, 1892 and *Sphaeromopsis* Holdich and Jones, 1973.

The relationship of *Exosphaeroma* to the similar *Isocladus* Miers, 1976 and *Zuzara* Leach, 1818 is unresolved (Bruce and

Holdich, 2002). *Isocladus* and *Zuzara* are not precisely defined and include numerous ill-defined and poorly described species. Many of the 39 species, including those regarded as incertae sedis (see Appendix), have minimal descriptions. All of the Southern Hemisphere species need to be redescribed for there to be sufficient data to assess species differences, relationships or the biogeography of this genus.

Exosphaeroma agmokara sp. nov.

Figures 14–17

Material examined. Holotype. Male (7.7 mm), Broken Head, NSW, c. 28°42′S, 153°37′E, 30 Mar 1980, intertidal, on rocks at sand-rock interface, N.L. Bruce (QM W26727).

Paratypes. 6 males (7.0–7.4, immature 5.4, 5.6 mm), 5 females (ovigerous 5.8, 5.9, non-ovigerous 5.7–6.6 mm), 3 mancas (3.9–5.0 mm), same data as holotype (QM W8573).

Description of male. Body 1.8 times as long as greatest width, ovate, widest at pereonite 5; dorsal surfaces smooth, anteriorly with fine ridges. Cephalon anterior margin without transverse ridges, ventral rostral process weakly developed, not visible in dorsal view. Head about one-third as long as pereonite 1, p ereonite 1 about 1.5 times as long as pereonite 2; pereonite 2>3=4>5<6<7; pereonite 7 laterally shorter than 6, longer than pereonite 6 at median point. Pleon laterally about twice as long as pereonite 7, with sublateral 'keys'. Pleotelson strongly vaulted, posterior margin produced to acute apex; ventral margin anteriorly excavate.

Antennule peduncle article 1 1.4 times as long as wide, about 2.4 times as long as article 2, anterior and posterior margins convex; article 3 about two-thirds as long as article 1, 2.5 times as long as wide, 1.6 times as long as article 2; flagellum 16-articled, extending to posterior of pereonite 1, about 2.8 times as long article 3. Antenna relatively robust, peduncle articles 1 and 2 short, article 1 anterior margin with mass of setae, combined lengths about equal to that of article 5; article 3 about 1.2 times as long as article 4; article 4 about 0.6 as long as article 5, articles 3–5 collinear; flagellum about 1.4 times as long as peduncle, extending to middle of margin of pereonite 3, with 17 articles.

Epistome anteriorly truncate, anterior lateral margins straight, diverging to mid point, then narrowing to medial constriction. Left mandible incisor with 3 cusps, lacinia mobilis with 3 cusps, spine row of 7–8 curved serrate spines; right mandible with 3 indistinct cusps, spine row of 2 broad-based multidigitate spines, 11 serrate spines; molar process round, crushing surface strongly ridged; palp articles 1 and 2 subequal in length, article 2 distolateral margin with 16 finely biserrate setae; article 3 with 18 biserrate setae, terminal 2 setae being longest. Maxillule mesial lobe with 4 long, strongly CP RS, lateral lobe with 10 RS on gnathal surface, twelfth seta set between these; 4 lateral-most and mesial-most RS simple, others strongly serrate. Maxilla lateral lobe and middle lobe each with 9 curved finely serrate RS respectively, mesial lobe with about 20 serrate and biserrate RS, many of which are weakly spatulate, proximal seta longest. Maxilliped endite lateral margin strongly convex, distal margin with 1 simple RS at sublateral angle, 5 curved CP RS, 8 mesially bent CP RS; distomesial margin with 5 large stout CP RS, increasing in size proximally; palp articles 2–5 with about 26, 30, 30 and 24 setae respectively.

Pereopod 1 with inferior margin of distal half of ischium and entire margin of merus to propodus with dense setulose fringe; basis about 2.8 times as long as greatest width, approximately twice as long as propodus; superior margin with 3 close-set short simple setae at midpoint; ischium 0.8 times as long as basis, 2.3 times as long as greatest width, superior margin weakly setulose with 4 prominent acute simple setae; merus short, about 0.3 times as long as ischium, about 0.7 times as long as greatest width, superior distal angle with 5 acute long simple setae, inferior margin with 5 setae distal-most only being long and extending beyond setulose fringe; carpus 0.8 times as long as wide, inferior margin with 1 long seta and distally with 1 RS; propodus 2.0 times as long as greatest width, 0.7 times as long as ischium, inferior margin with 2 setae and distally with 1 RS; dactylus 0.8 times as long as propodus, unguis inferior margin with prominent serrate cuticular scales, secondary unguis recurved simple. Pereopods 2–7 subsimilar, pereopod 7 slightly shorter than pereopod 6. Pereopod 2 basis 2.4 times as long as greatest width, inferior proximal margin and submarginal surface with setulose fringe; inferodistal angle with single simple seta, superior margin with widely spaced small setae; ischium 0.8 times as long as basis, 2.3 times as long as greatest width, superior distal margin with 4 prominent simple setae, inferior margin with setulose fringe at distal angle only; merus about half as long as ischium, superior distal angle with 2 long simple seta, inferior margin with dense setulose fringe with 4 short and 1 long simple seta; carpus slightly (1.1) times longer than merus, 1.6 times as long as greatest width, anterodistal angle with 2 small simple seta, inferior margin with dense setulose fringe, with 5 long simple setae; propodus 0.9 times as long as ischium, superior distal angle with 3 setae one of which is palmate, inferior margin with dense setulose fringe, with 8 simple setae none of which greatly exceed length of setulose fringe; dactylus 0.4 as long as propodus. Pereopods 5–7 similar, longer and with more RS than pereopods 1 and 2, pereopod 7 noticeably more slender that pereopod 6. Pereopod 7 basis 4.2 times as long as greatest width, inferodistal angle with single simple seta, superior margin with 4 widely spaced small setae, distally with group of 4 palmate seta, proximal inferior margin with setulose patch; ischium 0.6 times as long as basis, 2.9 times as long as greatest width, proximal superior margin with 4 prominent long simple setae, inferior distal angle with 1 short simple setae; merus half as long as ischium, superior distal angle truncate, with 5 long simple setae, inferior distal margin with setulose fringe with 2 simple setae; carpus 1.3 times as long as merus, anterodistal margin with 8 acute biserrate and 3 simple RS, inferior margin with setulose fringe with 4 simple setae, inferior distal angle with 2 stout biserrate RS; propodus about as long as ischium, 4.8 times as long as wide, inferior margin setulose but less dense than merus and carpus, distally with 2 short simple RS, superior distal angle with 1 simple and 1 palmate seta; dactylus 0.4 as long as propodus.

Penes slender, 4.5 times as long as basal width; separated by about twice basal width of penial process, angled mesially, weakly curved.

Pleopod 1 exopod and endopod with c. 35 and 27 PMS

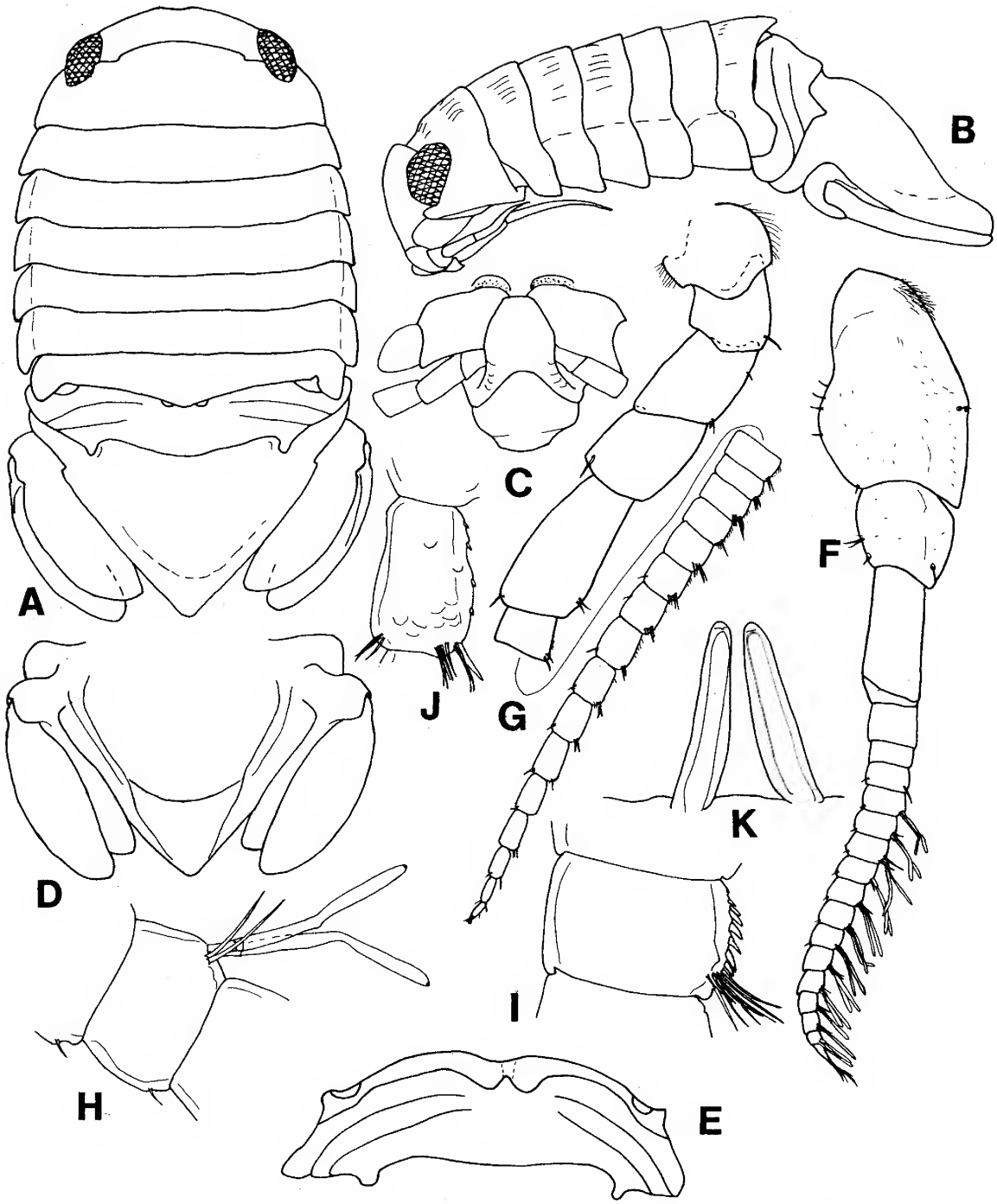

Figure 14. *Exosphaeroma agmokara* sp. nov. A–E, holotype, remainder ♂ paratype. A, dorsal view; B, lateral view; C, frons; D, pleotelson, ventral view; E, pleon; F, antennule; G, antenna; H, antennule flagellum article 6; I, antenna, flagellum article 5; J, antenna, flagellum article 13; K, penes.

Figure 15. *Exosphaeroma agmokara* sp. nov. A, right mandible; B, left mandible; C maxillule lateral lobe; D, maxillule; E, maxilla, e, RS from mesial lobe, ee, RS from lateral and middle lobes; F, maxilliped; G, maxilliped endite, dorsal surface; H, pereopod 1 dactylus.

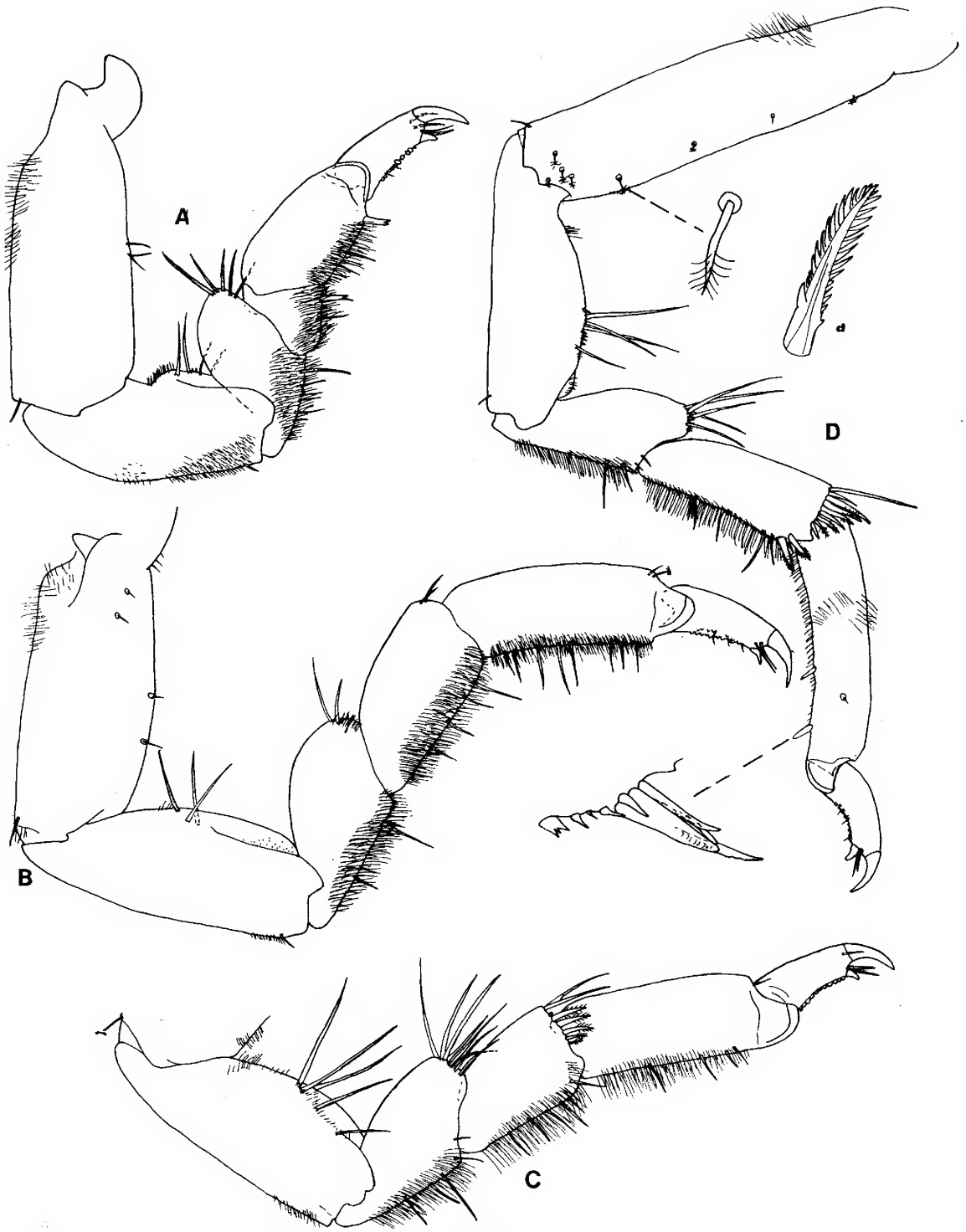

Figure 16. *Exosphaeroma agmokara* sp. nov. A–D, pereopods 1, 2, 6, 7, with detail of pereopod 7 setae; d, robust seta from carpus distal margin.

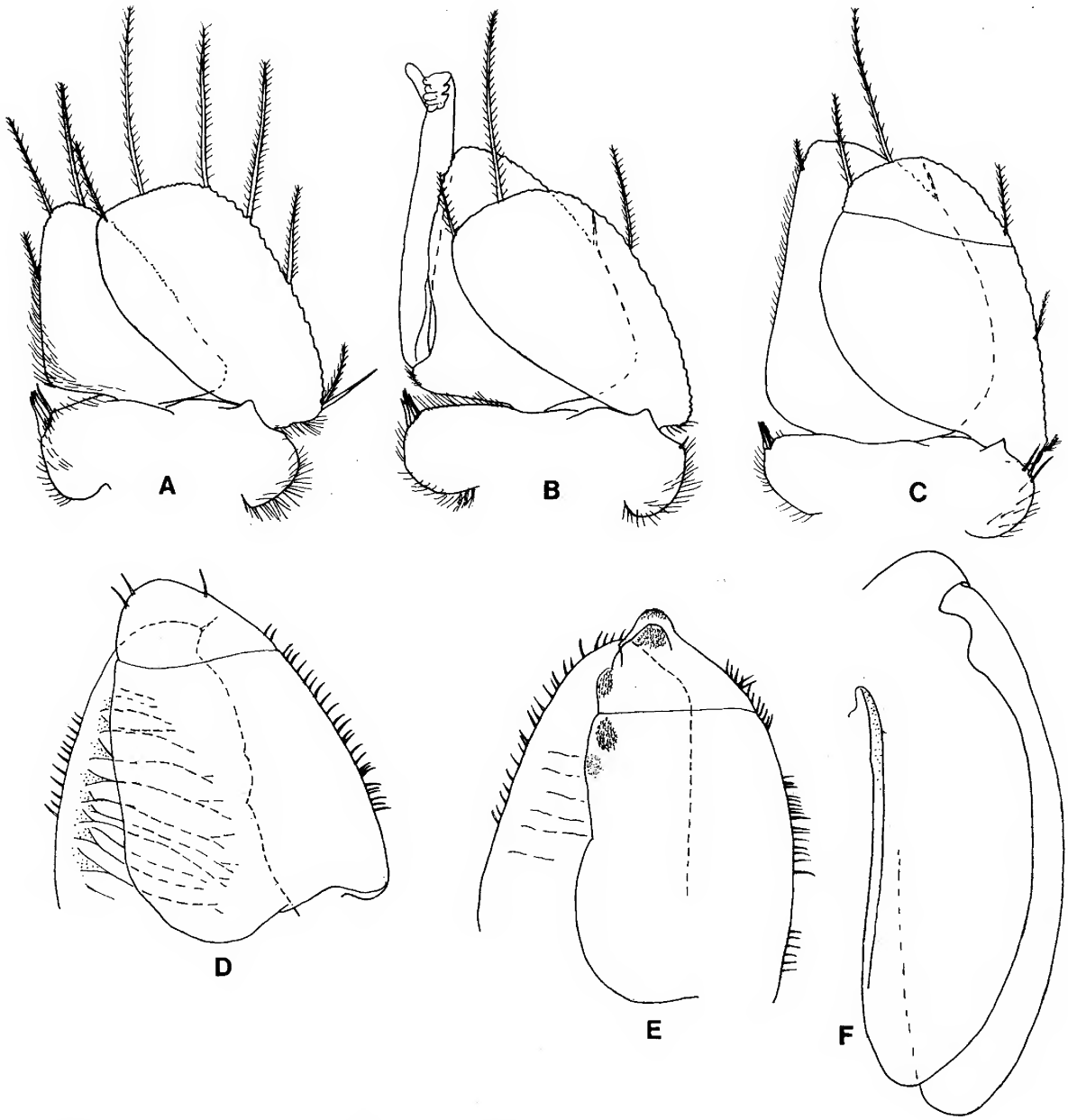

Figure 17. *Exosphaeroma agmokara* sp. nov. A–E, pleopods 1–5; F, uropod.

respectively, exopod proximolateral RS prominent; endopod 0.7 as long as exopod, 1.5 times as long as greatest width. Pleopod 2 exopod and endopod with c. 42 and 30 PMS respectively; appendix masculina 12 times as long as wide, distally highly folded and glandular in appearance, apically rounded, Pleopod 3 exopod and endopod with c. 45 and 19 PMS respectively; exopod transverse suture entire. Pleopod 4 endopod with prominent thick ridges, lateral, exopod transverse suture entire, distal margin with 3 short simple setae, lateral margin with continuous evenly spaced fine simple setae. Pleopod 5 both endopod with feeble thickenings, without raised ridges, lateral margin with evenly spaced fine simple setae; exopod with 4 scale patches, 3 distal to suture, lateral margin with numerous evenly spaced simple setae, with obscure proximal lobe. Uropod exopod extending slightly beyond endopod, about 3 times as long as wide; endopod about twice as long as wide; both

rami with lateral margins evenly convex distal margin evenly rounded.

Female. Similar to male.

Size. Males 7.0–7.7 mm, ovigerous females 5.8 5.9 mm, non-ovigerous females, 5.7–6.6 mm, mancas 3.9–5.0 mm.

Etymology. From Greek *agmo* (break) and *kara* (head), alluding the type locality; noun in apposition.

Distribution. Known only from the type locality, Broken Head, northern NSW.

Remarks. Many species of *Exosphaeroma* (Appendix) are similar. *Exosphaeroma agmokara* sp. nov. is best identified by the posterior margin of pereonite 7 being weakly produced to form a median point which overrides pleonite 1, the evenly rounded uropodal rami which extend to about the end of the pleotelson (i.e. not extending noticeably beyond nor falling short of the pleotelson apex), the apex of the pleotelson being weakly produced and acute, the narrowly truncate anterior margin of the epistome and, in the male, by the distal margin of the appendix masculina being bent with the subdistal part being heavily folded (concertina-like).

No Australian species of *Exosphaeroma* has pereonite 7 produced to form a median point, while *E. serventii* Baker, 1928 has the uropodal exopod distally acute; *E. bicolor* Baker, 1926 has the uropodal exopod longer than the endopod and distally acute, and an anteriorly rounded epistome; *E. laevis* (Baker, 1910) has an anteriorly acute epistome; *E. aliae* Baker, 1926 has a broadly subtruncate pleotelson and anteriorly acute epistome; and *E. varicolor* Barnard, 1914 has proportionally wider uropods, the pleotelson bearing two short anteriorly-positioned submedian ridges.

Similar species are the larger *E. gigas* (Leach, 1818) (Brandt and Wägele, 1989) from the Southern Ocean, *E. obtusum* (Dana, 1853, sensu Hurley and Jansen, 1978) from New Zealand and *E. pallidum* Barnard, 1940 from South Africa. Of these only *E. obtusa* has pereonite 7 forming a median point but can be distinguished by the widely truncate epistome, more bluntly rounded uropodal rami and the subdistal margins of the pleotelson being convex rather than straight. The shape of pereonite 7 is not mentioned in the poorly-known *E. pallidum*, which can be separated from *E. agmokara* by having lanceolate uropodal rami.

Exosphaeroma alveola sp. nov.

Figures 18–22

Material examined. Holotype. Male (6.5 mm), near mouth of Moona Moona Creek, Jervis Bay, **NSW,** 34°04.5′S, 150°41.0′E, 23 Jan 1982, 4.5 m, on test of ascidian *Herdmania*, P.B. Berents (AM P51055).

Paratypes. **NSW.** 3 males (6.0 mm), 2 females (non-ovigerous 3.5, 4.2 mm), E of Fairy Bower, Manly, 33°48′S, 151°17′E, 22 Nov 1984, 6 m, sand between rocks, J. Just (AM P41189). 2 females (non-ovigerous 4.3, 4.4 mm), Edwards Beach, Middle Harbour, Sydney, 33°49.4′S, 151°15.1′E, 17 Mar 1985, under rocks at low tide, N.L. Bruce (AM P41389). Male (7.1 mm), same as previous, 23 Mar 1985 (AM P41382). 5 males (4.6–[6.7 dissected] mm), 11 females (non-ovigerous 3.0–4.6 mm), same data as holotype (AM P51056). Male (5 mm, rolled), Murrumbulga Point, Twofold Bay, 37°05′S, 149°54′E, 17 Sep 1985, intertidal rock platform, P.A. Hutchings and S.J. Keable (AM P41201). 2 males (5.5, 6.6 mm), Quarantine Bay, Murrumbulga Point, Twofold Bay, 37°05′S, 149°54′E, 17 Sep 1985, subtidal breakwater, P.A. Hutchings and S.J. Keable (AM P41202). 2 females (5.5, 3.0 mm), Murrumbulga Point, Twofold Bay, 37°05′S, 149°54′E, 9 Oct 1985, subtidal rock, P.A. Hutchings and S.J. Keable (AM P35955). **Tas.** 4 females (4.0–5.5 mm), 3 females (?3.8, 4.0, 4.3 mm), Governor I., Bicheno, 41°52′S, 148°19′E, 29 May 1984, 30 m, on bryozoan, (NMV J26419).

Description of male. Body heavily calcified, 1.7 times as long as greatest width, dorsum noticeably flattened, lateral margins distinctly thickened, approximately straight in dorsal view, diverging, widest at pereonite 6; dorsal surfaces minutely punctate. Head about 1.3 times as long as pereonite 1, dorsally deeply corrugated; pereonite 1> 2>3=4>5<6<7; pereonite 7 laterally narrower than 6, not forming part of body outline, laterally wholly overlapped by coxae of pereonite 7. Pleon laterally about as long as pereonite 7 in lateral view (flexure makes this difficult to measure accurately), with median weakly elevated region, with evident sublateral 'keys'. Pleotelson strongly vaulted, posterior margin produced to bluntly rounded apex; ventral margin anteriorly excavate; dorsal margin mesially raised, with 2 obscure punctate submedian ridges uniting at about midpoint, expanding at posterior margin.

Antennule peduncle article 1 1.4 times as long as wide, about twice as long as article 2, anterior margins convex, distal one-third somewhat produced; article 3 about two-thirds as long as article 1, 3.7 times as long as wide, 1.3 times as long as article 2; flagellum 7-articled, extending to posterior of pereonite 1, about 1.5 times as long article 3; antennule peduncles prominently visible in dorsal view. Antenna relatively robust, peduncle articles 1 and 2 short, article 1 anterior margin with mass of setae, combined lengths of articles 1 and 2 about equal to that of article 5; article 3 about 0.8 times as long as article 4; article 4 about 0.6 as long as article 5, articles 3–5 collinear; flagellum about 0.8 times as long as peduncle, extending to posterior margin of pereonite 1, with 12 articles.

Epistome prominently visible in dorsal view, anteriorly truncate, anterior lateral margins straight, diverging to midpoint, then narrowing to medial constriction; ventral surface pitted, centrally depressed. Left mandible incisor with 4 cusps, lacinia mobilis with 3 cusps, spine row of 8 curved serrate spines; right mandible with 3 indistinct cusps, spine row of 2 broad-based multidigitate spines, 8 serrate spines; molar process round, crushing surface strongly ridged; palp article 2 longest, article 2 distolateral margin with 9 stout and prominently biserrate setae; article 3 with 12 prominently biserrate setae, 2 terminal setae being longest. Maxillule mesial lobe with 4 long, strongly CP RS and 1 simple slender seta, lateral lobe with 11 RS on gnathal surface, twelfth seta set between these; gnathal RS variously serrate, submesial RS being most strongly serrate. Maxilla lateral lobe and middle lobe each with 9 curved finely serrate RS respectively, mesial lobe with about between 12–18 serrate and biserrate RS (number could not be clearly observed), proximal seta longest. Maxilliped endite lateral margin strongly convex, distal margin with 1 simple RS at sublateral angle, 5 curved CP RS, 2 short straight CP RS; distomesial margin with 3 large stout CP RS, increasing in size

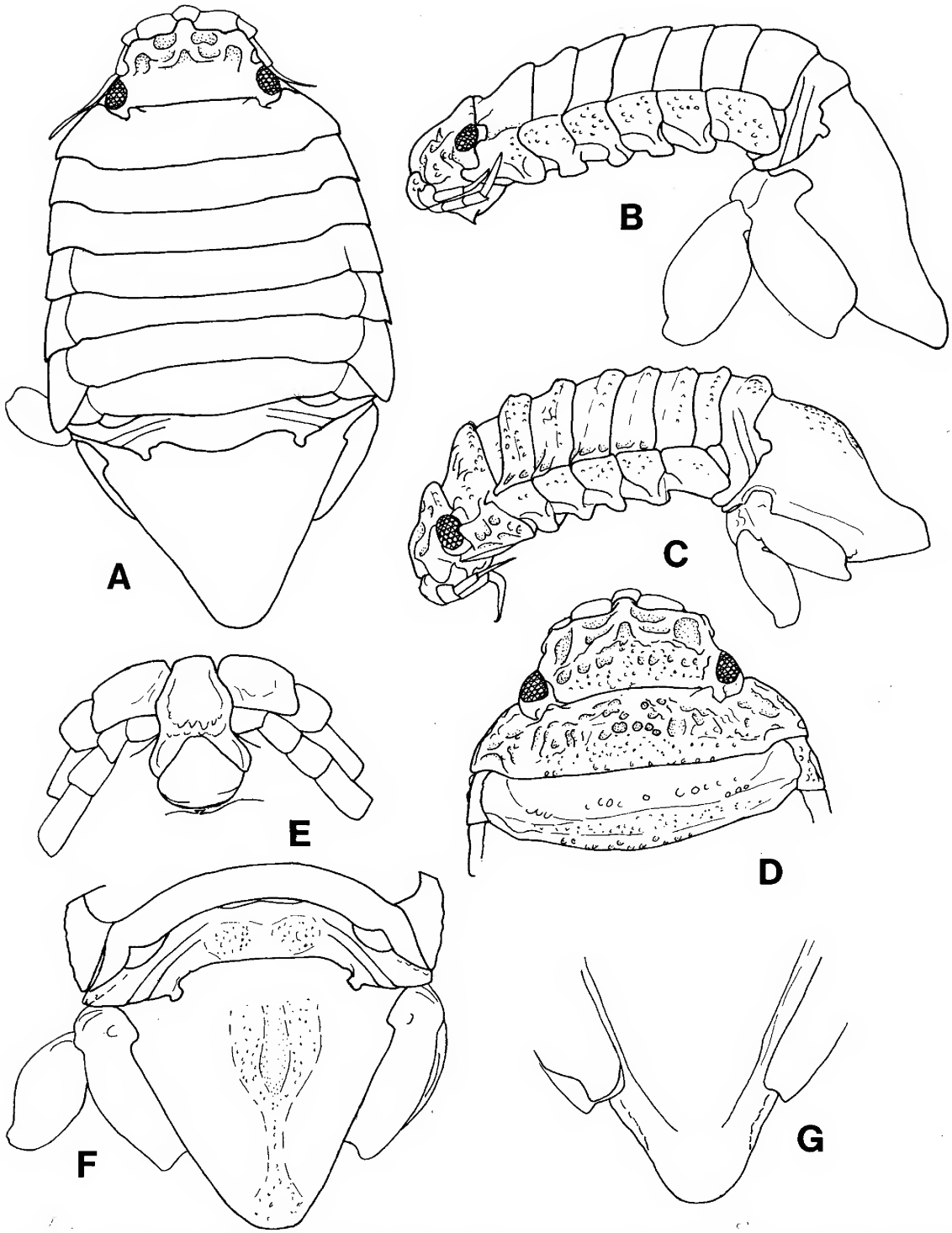

Figure 18. *Exosphaeroma alveola* sp. nov. A, B, E, G, holotype, remainder as indicated. A, dorsal view; B, lateral view; C, lateral view female; D, dorsal view, head and pereonite 1, female; E, frons; F, pleon and pleotelson, female; G, pleon, posterior margin, ventral view.

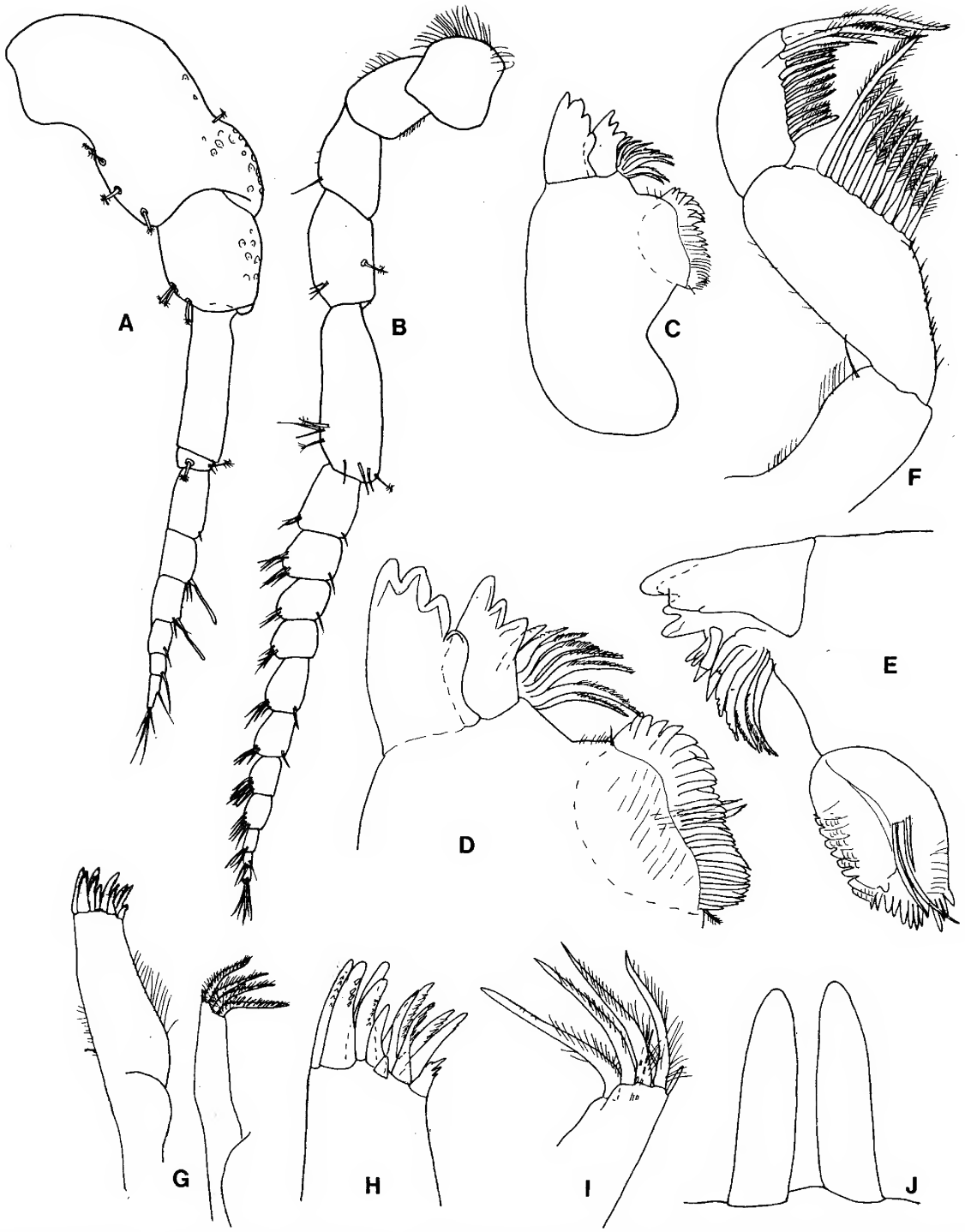

Figure 19. *Exosphaeroma alveola* sp. nov. A, antennule; B, antenna; C, left mandible; D, left mandible, distal part; E, right mandible, distal part; F, mandible palp; G, maxillule; H. maxillule, gnathal end, lateral lobe; I, maxillule, lateral lobe; J, penial processes.

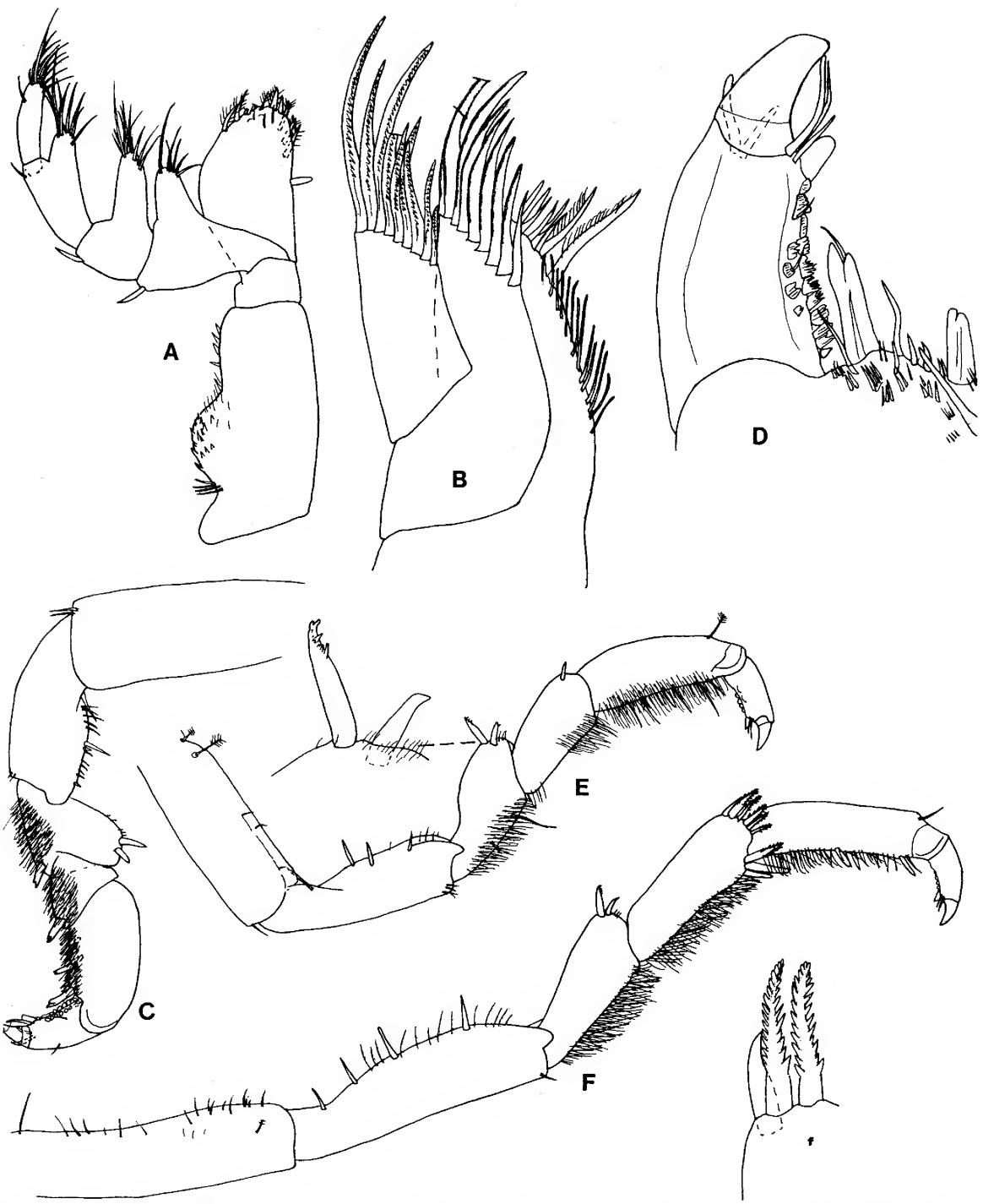

Figure 20. *Exosphaeroma alveola* sp. nov. A, maxilliped; B, maxilla; C, pereopod 1; D, pereopod 1, dactylus; E, pereopod 2; F, pereopod 7, f, RS from carpus superior distal angle.

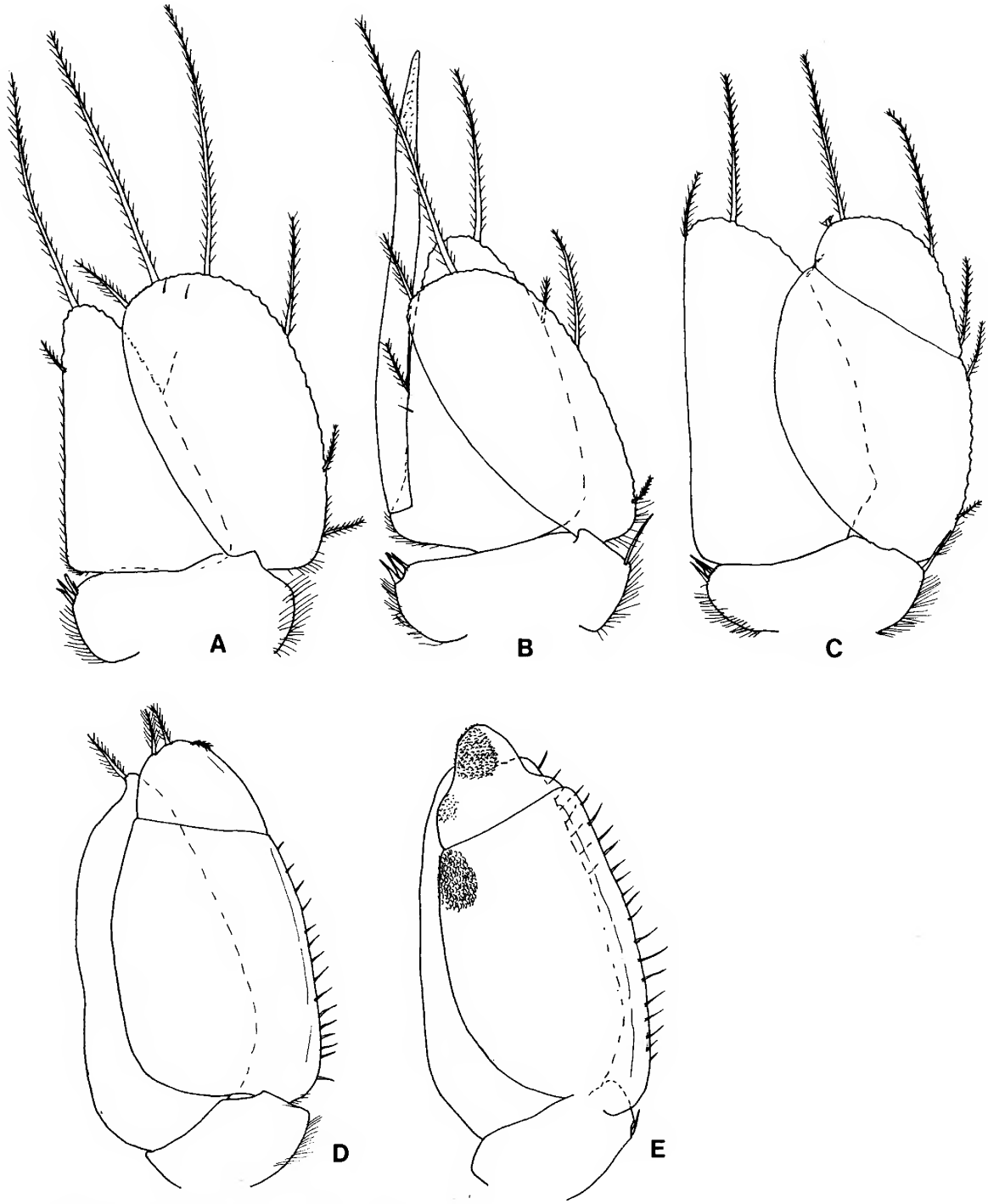

Figure 21. *Exosphaeroma alveola* sp. nov. A–E, pleopods 1–5.

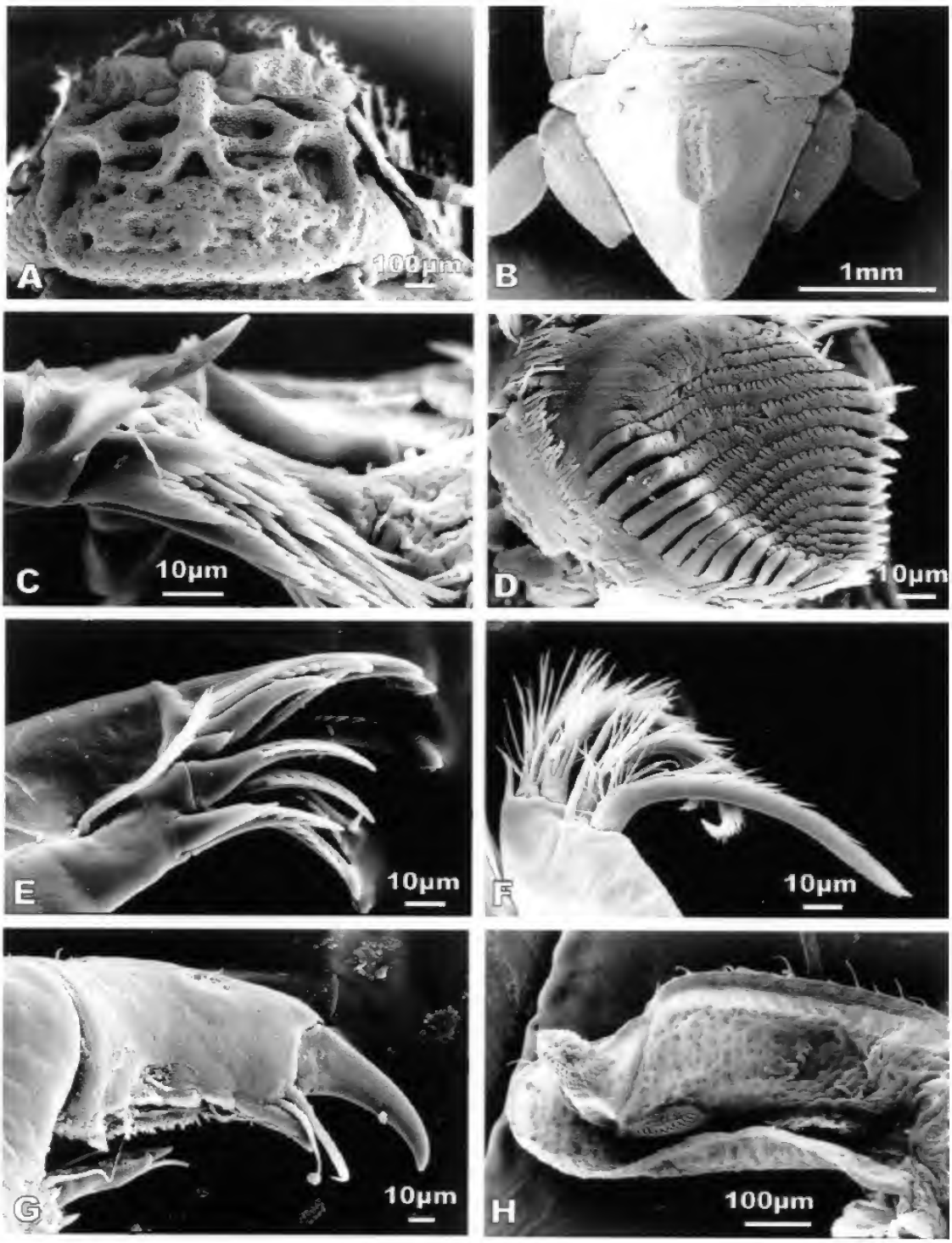

Figure 22. *Exosphaeroma alveola* sp. nov. SEMs. Female, AM P51056. A, head; B, pleon, dorsal view; C, right mandible, spine row; D, right mandible, molar; E, maxillule, lateral lobe; F, maxillule, mesial lobe; G, pereopod 1, dactylus; H, pleopod 5, exopod.

proximally; palp articles 2–5 with about 11, 14, 16 and 14 setae respectively.

Pereopod 1 basis about 2.7 times as long as greatest width, 1.7 times as long as propodus; margins without setae, inferodistal angle with single seta; ischium 0.6 times as long as basis, about as long as propodus, twice as long as greatest width, superior margin with scattered scale-setae, with 2 prominent mesial acute simple setae, one proximal and 1 at midpoint, inferior margin without setae; merus short, about half as long as ischium, about 0.8 times as long as greatest width, superior distal angle with 2 short RS, inferior margin with dense setulose fringe, with 1 apically bifid RS at distal angle; carpus 0.8 as long as wide, inferior margin with dense setulose fringe, distally with 1 apically bifid RS; propodus 2.0 times as long as greatest width, about as long as ischium, inferior margin setulose, with 3 apically bifid setae; dactylus 0.6 times as long as propodus, unguis inferior margin with prominent serrate cuticular scales, secondary unguis recurved, blunt, simple. Pereopods 2–7 subsimilar, slender. Pereopod 2 basis 3.3 times as long as greatest width, inferior margin with 2 minute widely spaces setae; inferodistal angle with single simple seta, superior margin proximally with 2 palmate setae, with widely spaced small setae; ischium 0.9 times as long as basis, 3.3 times as long as greatest width, superior margin with 3 prominent acute RS, one set proximally, 2 set at midpoint, slender seta distally, inferior margin setulose at distal angle only; merus about half as long as ischium, superior distal angle with 2 apically serrate RS, inferior margin with dense setulose fringe with 4 short setae and 1 long simple seta; carpus slightly (1.1) times longer than merus, 1.9 times as long as greatest width, anterodistal angle with 1 short RS, distal half of inferior margin densely setulose; propodus 1.4 times as long as ischium, superior distal angle with 1 palmate seta, inferior margin with dense setulose fringe, with 6 simple setae none of which greatly exceed length of setulose fringe; dactylus about half as long as propodus. Pereopods 5–7 similar, longer and with more RS than pereopods 1 and 2. Pereopod 7 basis 4.8 times as long as greatest width, inferior margin without setae, superior margin with numerous widely spaced small setae, distally with 1 palmate seta; ischium 0.8 times as long as basis, 3.6 times as long as greatest width, proximal superior margin setulose with 4 prominent acute RS, inferior distal angle with 1 short simple setae; merus about half as long as ischium, superior distal angle with 2 short acute distally serrate RS, inferior margin with dense setulose fringe with 1 distally bifid RS; carpus 1.3 times as long as merus, anterodistal margin with 6 acute biserrate and 1 simple RS, inferior margin with dense setulose fringe, inferior distal angle with 1 simple and 2 stout biserrate RS; propodus about as long as ischium, 4 times as long as wide, inferior margin setulose but less dense than merus and carpus, distally with 2 short simple RS, superior distal angle with 1 simple and 1 palmate seta; dactylus 0.4 as long as propodus.

Penes 3.4 times as long as basal width; separated by about half basal width of penial process, straight with subacute apex.

Pleopod 1 exopod and endopod with c. 33 and 17 PMS respectively, exopod proximolateral RS prominent; endopod about as long as exopod, 1.7 times as long as greatest width. Pleopod 2 exopod and endopod with c. 34 and 22 PMS respectively; appendix masculina 18 times as long as wide, straight, distally glandular in appearance, apically acute, extending beyond endopod by 0.4 of its length. Pleopod 3 exopod and endopod with c. 37 and 14 PMS respectively; exopod transverse suture entire. Pleopod 4 rami without folds, distally with 1 PMS; exopod transverse suture entire, distal margin with 2 short PMS, lateral margin proximal to suture with continuous evenly spaced fine simple setae. Pleopod 5 with both rami lacking folds, endopod lateral margin with evenly spaced fine simple setae; exopod transverse suture entire, with 3 scale patches, 2 distal to suture, lateral margin with numerous evenly spaced simple setae. Uropod rami subequal in length, rami not extending beyond posterior margin of pleon, exopod with lateral margin convex with apex laterally falcate, endopod distally subtruncate with distolateral angle produced.

Female. Slightly smaller than males; body shape generally similar to that of male, dorsal surface markedly more ornamented.

Size. Males 4.6–6.6 mm, females 3.0–4.6 mm.

Etymology. From Greek *alveus* (cavity, pit), alluding the pitted surfaces of this species.

Distribution. Southern NSW, Tas.; from ascidians, bryozoans, under rocks and in sand from intertidal to 6 m in NSW, 30 m in Tas.

Remarks. Although the large uropods and coarsely pitted dorsal surfaces of this species immediately separates it from all other species, *Exosphaeroma alveola* is strikingly similar to the South African *E. planum* Barnard, 1914 in the shape of the pleotelson and uropods, pleotelson ornamentation and the somewhat flattened body shape. In contrast to *E. planum* the posterior margin of the pleotelson extends well beyond the uropods.

Four Southern Hemisphere species of *Exosphaeroma* have similar pleotelson ornamentation, with the anterior dorsal surface with two submedian ridges and the posterior part being somewhat produced, with a median ridge. These species are *E. antikraussi* Barnard, 1940, *E. kraussi* Tattersall, 1913, *E. varicolor* Barnard, 1914 (also recorded from Australia by Hale, 1929) all from South Africa, and *E. montis* (Hurley and Jansen, 1978) comb. nov. (Appendix) from New Zealand.

Most species of *Exosphaeroma* have a group of long, simple setae at the midpoint of the superior margin of the ischium and at the distal margin of the merus of the pereopods. This is shown by the type species (Brandt and Wägele, 1989), *E. agmokara* sp. nov., *E. bruscai* (Espinosa-Peréz and Hendrickx, 2002) and *E. amplicauda* (Stimpson, 1857) (Kussakin, 1979), but has rarely been illustrated for other species. In the present species these setae are absent.

Koremasphaera gen. nov.

Type species. Koremasphaera colonus sp. nov., here designated.

Diagnosis. Pleotelson posterior margin entire, without ventral exit channel. Dorsal surfaces of pereonites 2–7, pleon and pleotelson densely setose. Pleon with 4 segments, sutures running to lateral margin. Antennule peduncle article 1 more than twice as long as article 2, articles 1 and 2 robust; article 3 slender, all

articles collinear. Maxilliped palp articles 2–4 each with distomesial angle strongly produced, those of 3–4 finger-like; article 5 elongate and finger-like; mesial margins with numerous long simple setae. Pleopods 4 and 5 without thickened folds or ridges. Uropods attached subdistally on pleon, both rami semicylindrical in section, apically acute, exopod apex with cuticular spike; pleotelson posterior margin entire.

Description of male. Body stout, about twice as long as greatest width, strongly vaulted; dorsal surface granular, with abundant setae. Head weakly immersed in pereonite 1. Eyes small, facets distinct. Pereon segments with raised posterior margins. Coxae distinctly demarcated, overlapping anterior over posterior, ventrally directed. Membrana cingula absent. Pleon of 4 segments, segment 1 largely concealed by pereonite 7, segments 2–4 indicated by 2 distinct suture lines running to lateral margins of pleon. Pleotelson posterior margin entire without distinct ventral exit channel. Pleonal sternite absent.

Antennule and antenna anteriorly positioned on head. Antennule peduncle articles 1 and 2 robust, article 1 more than twice as long as article 2; article 3 slender, all articles collinear; flagellum about as long as peduncle, extending to middle of pereonite 1. Antenna peduncle articles 1–2 short, subequal, shorter than 4–5, which become progressively longer; flagellum shorter than peduncle, extending to posterior of pereonite 1.

Epistome anteriorly narrowly rounded, apex overlapped by rostrum, medial constriction not present. Labrum unornamented. Mandible incisor multicuspid; molar process prominent, crushing, provided with marginal scale teeth; left mandible with prominent lacinia mobilis both mandibles with spine row of 5 or 6 spines; palp article 1 longer than articles 2 and 3. Maxillule lateral lobe with about 13 RS on gnathal surface, most of which are serrate; mesial lobe with 4 long RS, 3 of which are prominently serrate, and 2 short acute simple RS. Maxilla with all articles well developed; lateral and middle lobes with flat strongly curved and finely serrate RS, mesial lobe with several acute long RS, some of which are basally CP. Maxilliped endite distal margin numerous long acute CP setae and 3 long CP RS on distomesial margin; palp articles 2–4 with distomesial angle strongly produced, that of articles 3–4 finger-like, article 5 elongate and finger-like; mesial margins with numerous long setae, lateral margins of articles 2 and 3 without setae, article 4 with 1 distal seta.

Pereopods all ambulatory, robust; pereopods 1–3 subsimilar, more robust than 4–7; inferior margins of merus, carpus and propodus with serrate and CP RS; setulose fringe weakly developed; dactylus with prominent simple secondary unguis and 2 flattened setae arising at lateral margin, 2 flat setae at distolateral margin. Pereopods 6 and 7 inferior and distal margins of merus, carpus and propodus with numerous serrate and biserrate RS.

Penes paired, adjacent; short, about twice as long as basal width; not reaching pleopod peduncles.

Pleopods 1–3 both rami with PMS. Pleopod 1 exopod distal margin subtruncate, proximolateral angle with single short acute RS; endopod distinctly triangular in shape. Pleopod 2 with appendix masculina basally attached on mesial margin. Pleopod 3–5 exopods with complete suture. Pleopods 4 and 5 exopod and endopods without transverse thickened ridges; pleopod 5 endopod with 2 scale patches. Uropod attached in ventromesial position; both rami subcylindrical in section, subequal in length; both rami narrowing evenly to an acute apex, not extending significantly beyond posterior margin of pleotelson, exopod distally with hardened spike.

Female. Similar to male; brood-pouch unknown.

Etymology. From Greek *korema* (brush), coupled with the ending *-sphaera* to indicate family affinity; alluded to the densely setose dorsal surfaces (feminine).

Remarks. Koremasphaera is another monotypic genus difficult to characterise and define but its species defies placement in any existing genus. The most similar genera are *Cymodoce* Leach, 1814 and *Oxinasphaera* Bruce, 1997, both large genera. *Oxinasphaera* is unambiguously defined, the principle diagnostic apomorphic characters being the antennule peduncle spikes, epistome and pereon with cuticular spikes, and the short uropod exopod with a deeply bifid apex, all of which are absent in *Koremasphaera*. In addition *Oxinasphaera* usually has an excavate pleotelson posterior margin. Points of similarity include the very long finger-like prolongation of the mesial lobes of the mandible palp articles 3, 4 and 5, the penial morphology and the presence of weakly developed spikes on the pleon and pleotelson. *Cymodoce* is less similar, and differs in the pleotelson having an excavate posterior margin, in having both uropod rami lamellar (European species) or the exopod only lamellar (Indo-Pacific species; Bruce, 1997), slender and elongate penial processes, and in having the posterior of the pleotelson with a prominent dorsal hardened hemispherical medial dome.

The characters which serve to identify *Koremasphaera* are the densely setose dorsal body surfaces; the posterior margin of the pleotelson entire; uropod rami thickened and terminally acute; penial processes short, wide and adjacent; maxilliped palp articles 3–5 strongly produced and provided with long setae; and pleopods 4 and 5 without thickened folds or ridges. Uropod morphology in Sphaeromatidae is consistent within genera, at least when monophyly seems assured (e.g. *Sphaeroma* and *Oxinasphaera*) and the uropods of *Koremasphaera*, with both rami semicylindrical and apically acute and subequal in size, are unique and a putatives synapomorphy.

Koremasphaera colonus sp. nov.

Figures 23–27

Material examined. Holotype. Male (7.5 mm), "The Whaleback" bommie, 0.5 km S of Point Hicks, Vic., 37°48.5′S, 149°16.8′E, 8 Apr 1989, sponge/yellow zoanthid community in roof of cave, 13 m, G.C.B. Poore and R.S. Wilson (NMV J39723).

Paratypes. Female (non-ovigerous 11.5 mm), 5 immature (4.5–5.5 mm), 36 mancas (2.3–2.6 mm), same data as holotype (NMV J26403).

Description of male. Body twice as long as greatest width, lateral margins subparallel, widest at pereonite 5; dorsal surfaces of pereon, pleon and pleotelson densely setose, pereonites 6 and 7, pleon and pleotelson with small cuticular spikes. Head anterior margin without transverse ridges, rostral process visible in dorsal view, overlapping epistome ventrally; head

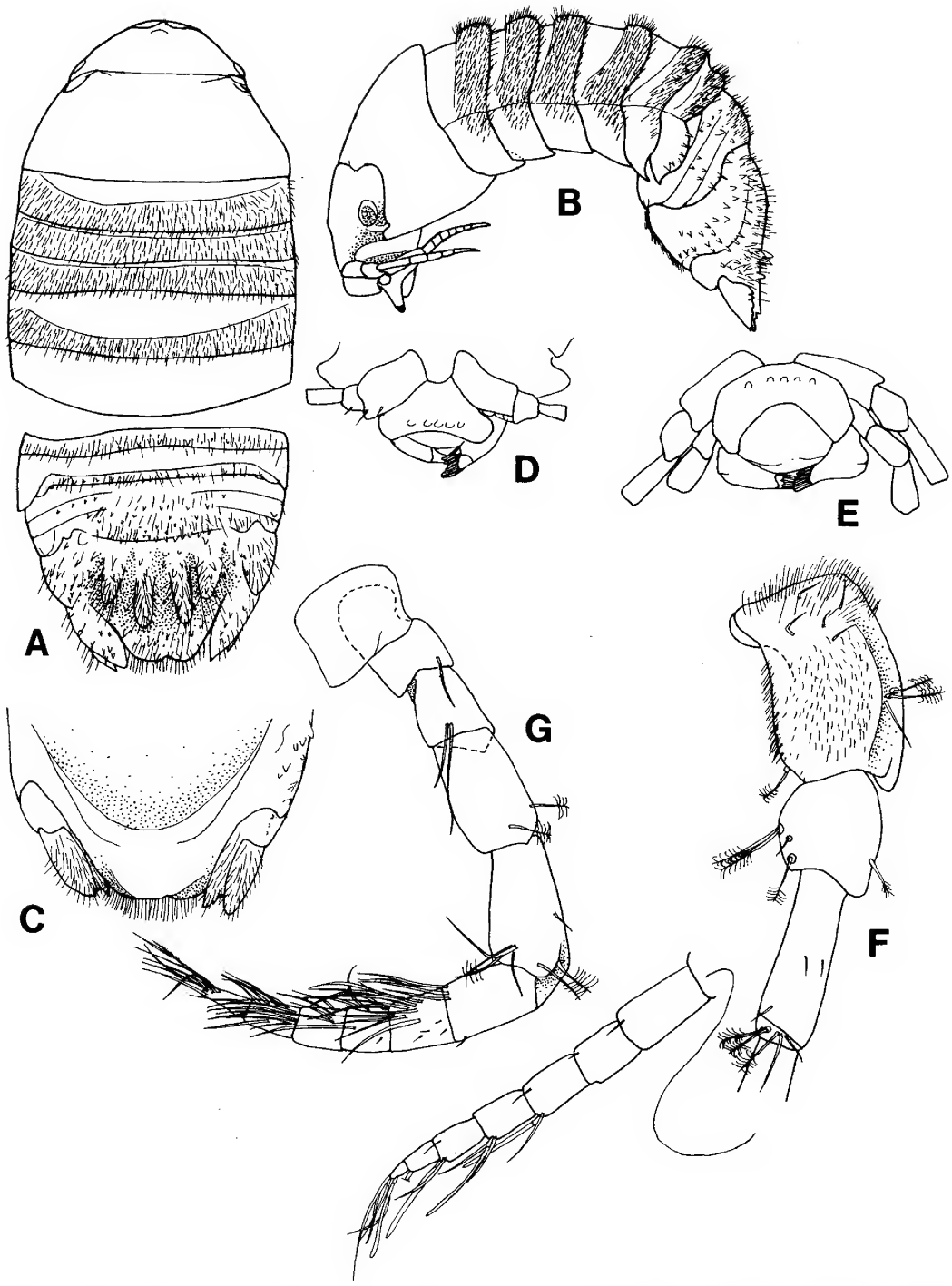

Figure 23. *Koremosphaera colonus* sp. nov. A–D, holotype, remainder as indicated. A, dorsal view; B, lateral view; C, pleon, posterior margin, ventral view; D, epistome, anterior view; E, epistome, ventral view; F, antennule; G, antenna.

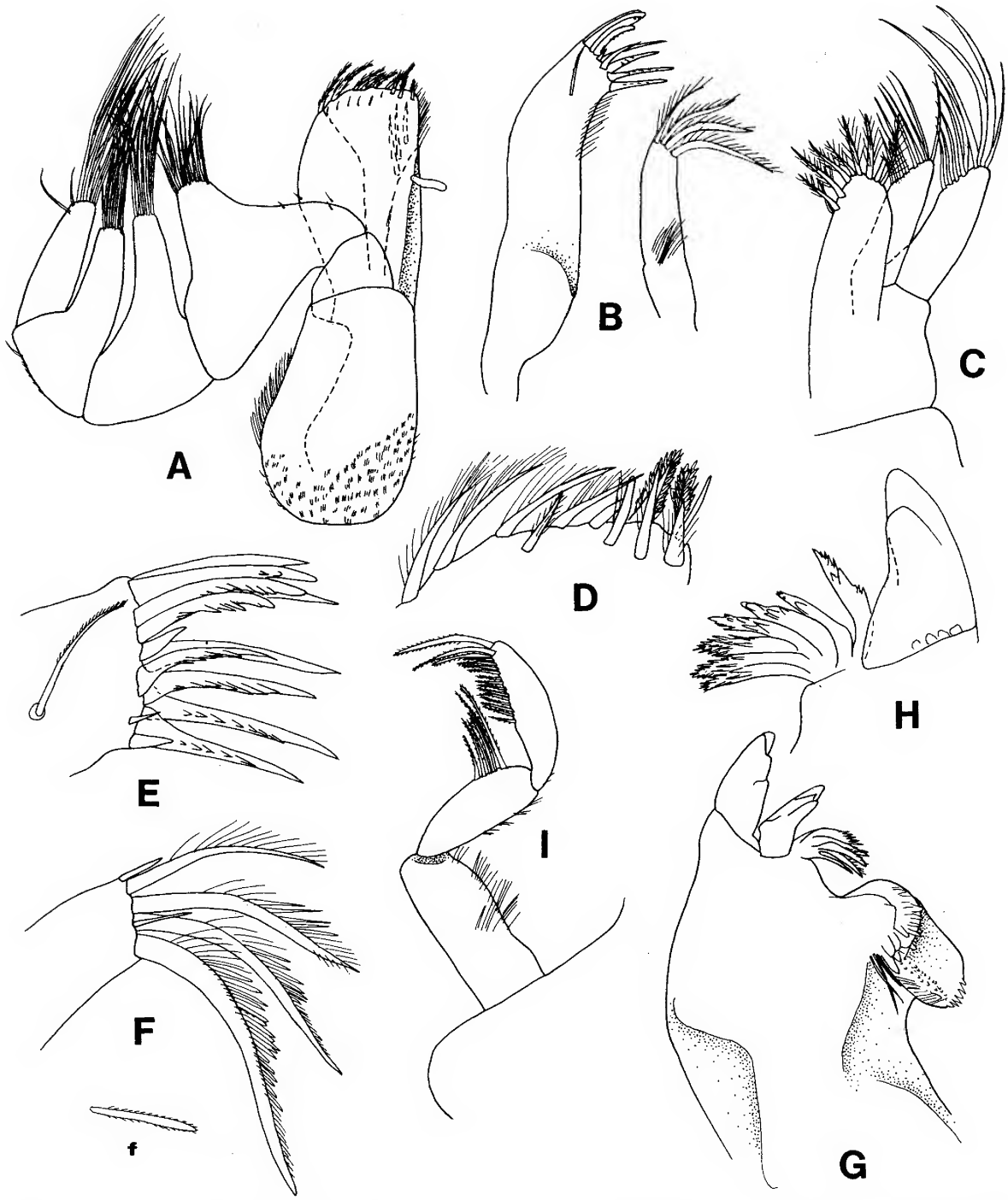

Figure 24. *Koremosphaera colonus* sp. nov. A, maxilliped; B, maxillule; C, maxilla; D, maxilliped endite, distal margin; E, maxillule, lateral lobe, f, gnathal RS; F, maxillule, mesial lobe; G, left mandible; H, right mandible, incisor and spine row; I, mandible palp.

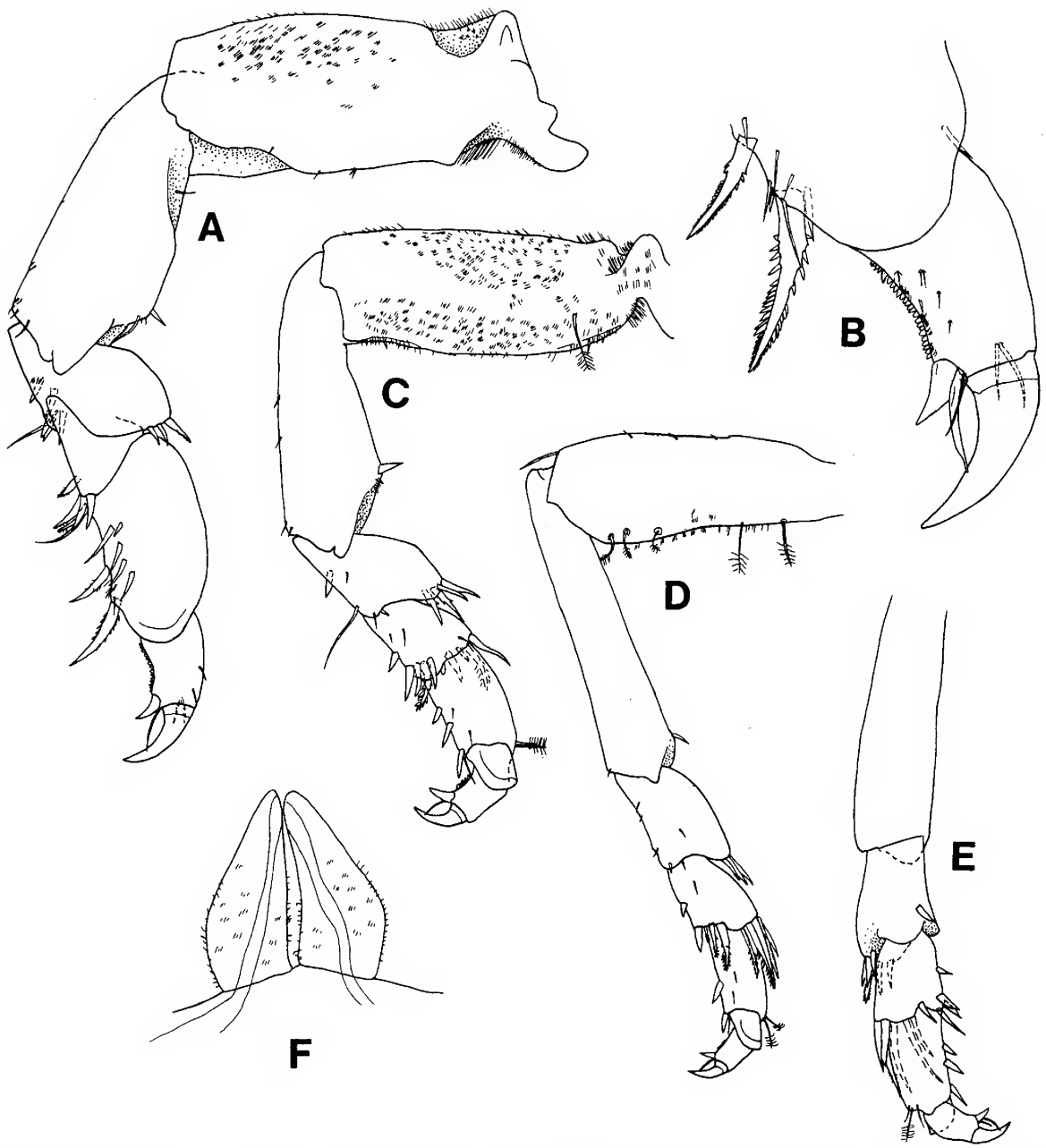

Figure 25. *Koremosphaera colonus* sp. nov. A, pereopods 1; B, pereopod 1, dactylus; C, pereopod 2; D, pereopod 7; E, pereopod 6, ischium–dactylus; F, penial processes.

about half as long as pereonite 1 in dorsal view; pereonite 1 dorsally smooth, pereonites 2–7 posteriorly with raised setose ridge, postero-ventral angles of coxae 5–7 produced to acute point, pereonite 1 about 1.5 times as long as pereonite 2; pereonite 2>3>4<5>6>7. Pleon laterally about twice as long as pereonite 7, with evident sutures, without pleonal sublateral 'keys'. Pleotelson strongly vaulted, posterior margin weakly produced and flat; dorsal surface with 4 indistinct subparallel longitudinal ridges, lateral ridges being shortest.

Antennule peduncle article 1 1.5 times as long as wide, about 1.9 times as long as article 2, anterior margin convex, with submarginal ridge, posterior straight, angled obliquely

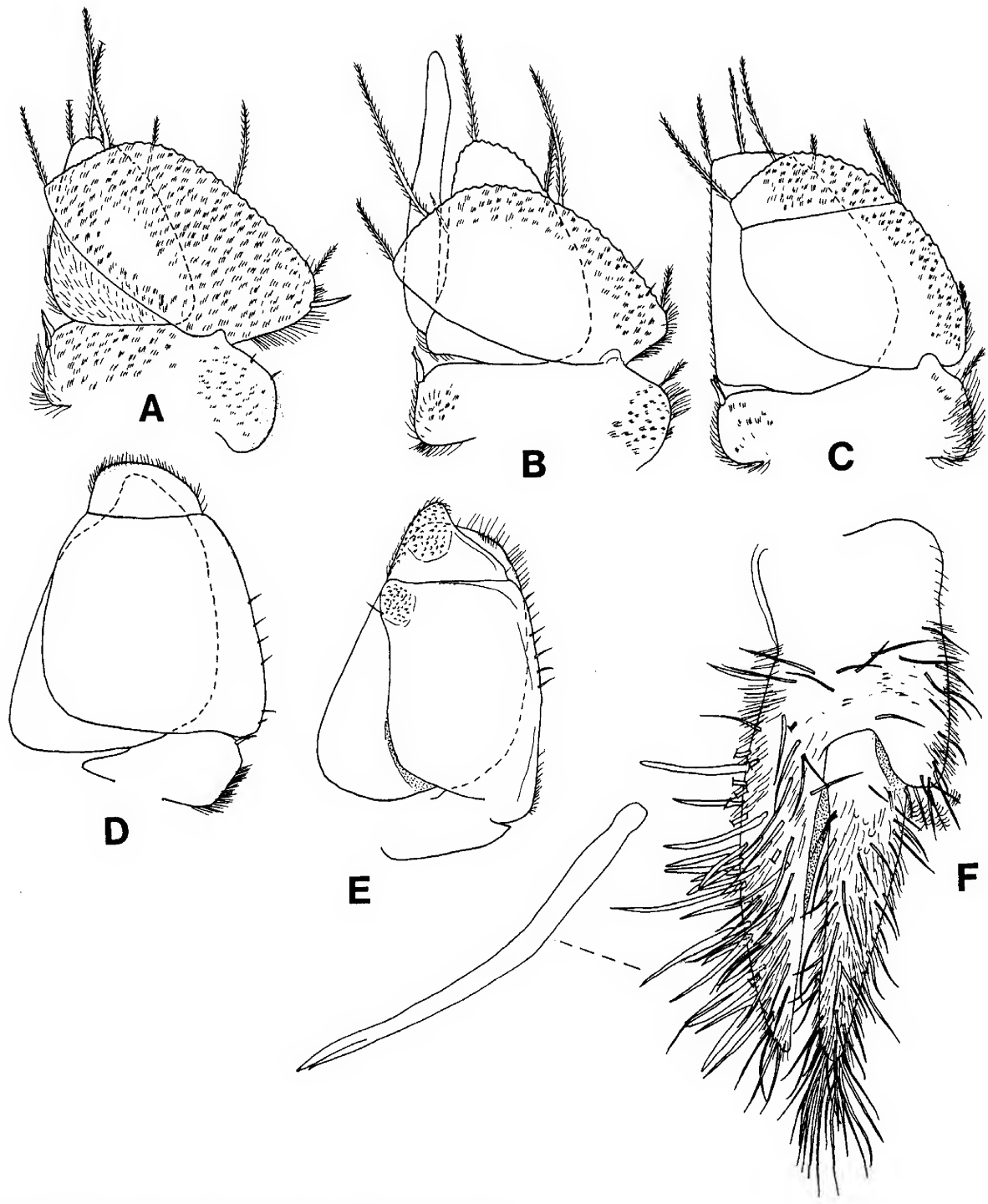

Figure 26. *Koremosphaera colonus* sp. nov. A–E, pleopods 1–5; F, uropod.

distally; article 3 about as long as article 1, about 4.1 times as long as wide, 1.7 times as long as article 2; flagellum 8-articled, extending to posterior of pereonite 1, about twice as long article 3. Antenna relatively robust, peduncle articles 1 and 2 short, article 1 quadrate, combined lengths of articles 1 and 2 about equal to that of article 5; article 3 about 0.6 times as long as article 4; articles 4 and 5 subequal in length, articles 3–5 collinear; flagellum stout, about 0.7 times as long as peduncle, extending to middle of margin of pereonite 3, with 6 densely setose articles.

Epistome anteriorly narrowly rounded, posterior surface with transverse row of 4 nodules. Left mandible incisor with 4 cusps, lacinia mobilis with 3 cusps, spine row of 5 curved serrate spines; right mandible with 2 indistinct cusps, spine row of 1 broad-based multidigitate spine and 6 distally serrate spines; molar process round, crushing surface strongly ridged; palp article 1 longest, articles 2 and 3 subequal in length, article 2 distolateral margin with 6 finely biserrate setae; article 3 with 17 biserrate setae, terminal 2 setae being longest. Maxillule lateral lobe with 12 terminally acute RS on gnathal surface, twelfth seta set between these. Maxilla lateral and middle lobes with 11 and 9 curved finely serrate RS respectively, mesial lobe with about 8 serrate and biserrate RS. Maxilliped endite lateral margin strongly convex, distal margin with 3 CP RS at sublateral angle, 2 cactus setae, 6 curved CP RS; distomesial margin with 35 large stout CP RS, increasing in size proximally.

Pereopod 1 basis about twice as long as greatest width, approximately twice as long as propodus; superior margin with few widely-spaced short simple setae, inferior lateral surface with numerous scale-setae; ischium 1.6 times as long as propodus, twice as long as greatest width, superior margin with 1 proximal and 1 distal acute short simple RS; merus about 0.3 times as long as ischium, 0.8 times as long as greatest width, superior distal angle with 3 acute simple RS inferior distal margin with 4 acute RS and 1 simple slender seta; carpus 1.2 times as long as wide, inferior margin 1.2 times as long as merus, distally with 1 biserrate, 4 acute RS and 1 slender seta; propodus 1.9 times as long as greatest width, inferior lateral margin with 5 short acute RS, inferior margin with 2 basally biserrate RS; dactylus 0.7 times as long as propodus, inferior margin with prominent serrate cuticular scales, secondary unguis simple, acute. Pereopods 2 and 3 similar to pereopod 1, less robust. Pereopod 2 basis 2.4 times as long as greatest width, lateral surfaces dense with scales, 1 proximolateral palmate seta; ischium 0.9 times as long as basis, 3 times as long as greatest width, superior margin with 1 proximal and 1 diastral acute short simple RS, inferior margin with 3 widely spaced short simple setae; merus about one-third as long as ischium, superior distal angle with 4 acute RS, inferior margin with 1 short stout acute RS and 1 long simple seta; carpus about as long as merus, anterodistal angle with 5 RS, 2 of which are biserrate, inferodistal margin with 5 acute RS, one of which is biserrate; propodus about half as long as ischium, 1.8 times as long as carpus, superior distal angle with 1 simple and 1 palmate setae, inferior margin with 3 short stout acute RS, distal-most being longest; dactylus 0.5 times as long as propodus. Pereopods 5–7 similar, ischium notably longer than for pereopods 1–3, distal margins of carpus with more and longer RS. Pereopod 7 basis 2.6 times as long as greatest width, inferodistal angle with single simple seta, superior margin with 2 proximal and 2 distal palmate setae, numerous widely spaced small scale-setae; ischium 1.1 times as long as basis, 4.5 times as long as greatest width, superior distal angle with 1 acute RS, merus one-third as long as ischium, superior distal margin with 3 acute RS, inferior margin 3 minute setae and 1 minute RS at distal angle; carpus about as long as merus, anterodistal angle with 5 long acute simple and serrate RS, inferior margin with 2 stout short acute RS, distal angle 3 biserrate RS; propodus 1.4 times as long as carpus, 0.4 times as long as ischium, superior distal angle with 2 palmate seta, inferior margin with 3 short stout acute RS, 1 at mid point, 2 at base of dactylus; dactylus 0.4 as long as propodus.

Pleopod 1 exopod and endopod with c. 32 and 11 PMS respectively, both rami densely setulose; endopod triangular, 0.6 times as long as exopod, 1.3 times as long as greatest width; exopod lateral and distal margins quadrate. Pleopod 2 exopod and endopod with c. 33 and 14 PMS respectively; appendix masculina 10 times as long as wide, slightly wider proximally, distally weakly bent laterally, apex bluntly rounded. Pleopod 3 exopod and endopod with c. 32 and 12 PMS respectively. Pleopod 4 exopod lateral margin with 7 fine simple setae, distal margin with continuous fine setae. Pleopod 5 exopod with distal scale patch large, forming mediodistal lobe, lateral margin with numerous simple setae, distal margins with long scale-setae; endopod with scale-setae on distal margin only. Uropod peduncle and rami densely covered with large distally bifid simple setae, palmate setae and scale-setae.

Female. Body shape generally similar to that of male, but dorsal surfaces lacking large setae, with smaller tubercles than in male, but with a densely pilose appearance from the abundant scale-setae.

Etymology. From Latin *colo* (dwell, inhabit), in the sense of a colony.

Distribution. Known only from the type locality, off Point Hicks, Vic.; possibly a commensal of sponges.

Remarks. The setose dorsal body surface in combination with the pleotelson posterior margin being entire and subcylindrical terminally acute uropod rami of about equal length all serve to identify the genus and species.

Margueritta Bruce

Margueritta Bruce, 1993: 164.

Type species. Margueritta sylviae Bruce, 1993, by original designation.

Species included and distribution. Margueritta sylviae Bruce, 1993; *Margueritta sandyi* sp. nov.; southern WA.

Remarks. The new species differs from the type species in the brood-pouch morphology. The type species was re-examined to ensure that the original diagnosis was correct. Harrison (1984a) considered brood-pouch morphology to show important generic characters, and the differences between the two species could be considered to be of generic merit. However some genera,

such as *Sphaeroma* (Harrison, 1984a) are known to be variable, and the two species *Margueritta* otherwise agree.

Margueritta sandyi sp. nov.

Figures 28–30

Material examined. Holotype. Female (3.2 mm, ovigerous), western side of Carnac I., off Fremantle, WA, 18 Dec 1971, 4–7 m, on algae, W.F. Ponder (AM P50939).

Paratypes. Female (2.9 mm, non-ovigerous), manca (1.5 mm), North Lumps, 2 km off Mullaloo, WA, 31°47.30′S, 115°42.80′E, 2 May 1986, 8 m, red algal turf adjacent to reef, G.C.B. Poore and H.M. Lew Ton (NMV J26053).

Holotype of *Margueritta sylviae* Bruce, 1993 (AM P41021).

Description of female. Body about 1.7 times as long as greatest width, ovate, widest at pereonites 2 and 3; dorsal surfaces smooth, with irregular series of low bosses these provided with scattered setae. Cephalon anterior margin anteriorly projecting over frons, medially indented; without transverse ridge, ventral rostral process weakly developed. Pereonites 1 about 1.6 times as long as head in length in lateral view, about 1.8 as long as pereonite 2, with 2 clusters of low sublateral bosses; pereonites 2–7 of approximately equal length; pereonites 2, 3 and 5 with submarginal irregular transverse row of low bosses; pereonite 4 with one large median boss and single boss at each lateral margin; pereonites 6 and 7 each with two submedian bosses, pereonite 6 with 2 additional low submarginal bosses; coxae with sutures, ventrally directed, each with dorsal boss. Pleonite 1 entire; pleon otherwise without evident sutures, posterior margin indicated short lateral suture. Pleotelson with prominent anteriorly positioned median boss; posterior margin with distinctly produced ventrally open tube extending beyond posterior of uropodal rami.

Antennule peduncle article 1 about 3.3 times as long as distal width, anterior margin with 3 stout simples setae and 1 palmate seta; peduncle article 2 about half as long as article 1, 1.7 times as long as wide, anterodistal margin with 1 long and 1 short simple setae and 3 palmate sensory setae; article 3 about 0.7 as long as article 2, weakly offset on posterior margin of article 2; flagellum 4-articled, extending to pereonite 1, about 2.8 times as long article 3. Antenna peduncle articles 1–3 short, combined lengths 1.5 times as long as article 5; article 4 about 0.8 as long as article 5, both articles 4 and 5 with inferior margins convex; flagellum about equal in length to peduncle, extending to anterior margin of pereonite 2, with 8 articles.

Epistome smooth, narrow, laterally encompassing labrum, not anteriorly produced. Mandible as for the genus. Maxillule mesial lobe with 2 long, weakly pectinate setae and 2 shorter simple seta, lateral lobe with 10 peripheral RS on gnathal surface. Maxilla lateral lobe and middle lobe each with 2 and 3 curved RS respectively, mesial lobe with 6 setae, variously circumplumose, mesial-most seta only being acute, remainder terminally rounded. Maxilliped endite extending to palp article 5, distal margin with 1 conical RS, 3 rounded RS, 2 cactus RS and 3 slender CP RS; palp articles 2–5 with about 6, 12, 10 and 10 setae respectively.

Pereopod 1 basis about 2.4 times as long as greatest width, 1.6 times as long as propodus; inferodistal angle with 1 long simple setae; ischium 0.9 times as long as basis, 2.4 times as long as greatest width, margins with scale-setae more abundant on inferior margin; merus about 0.2 as long as ischium, 1.8 times as long as greatest width, inferior margin with sparse scale-setae and single long simple seta; carpus (inferior margin) 0.6 as long as merus, 0.4 as long as wide, with single simple seta; propodus 0.7 times as long as ischium, twice as long as greatest width inferior margin with single distal simple seta; dactylus about o.8 times as long as propodus, inferior margin with prominent serrate cuticular scales; unguis strongly recurved, secondary unguis recurved with 2 basal cusps. Pereopods 2 and 3 similar to pereopod 1, but with more and longer setae. Pereopods 5 and 6 similar, shorter than pereopods 1 and 2. Pereopod 7 slightly longer than pereopods 2–6, otherwise generally similar.

Pleopod 1 exopod and endopod with 8 and 9 PMS respec-

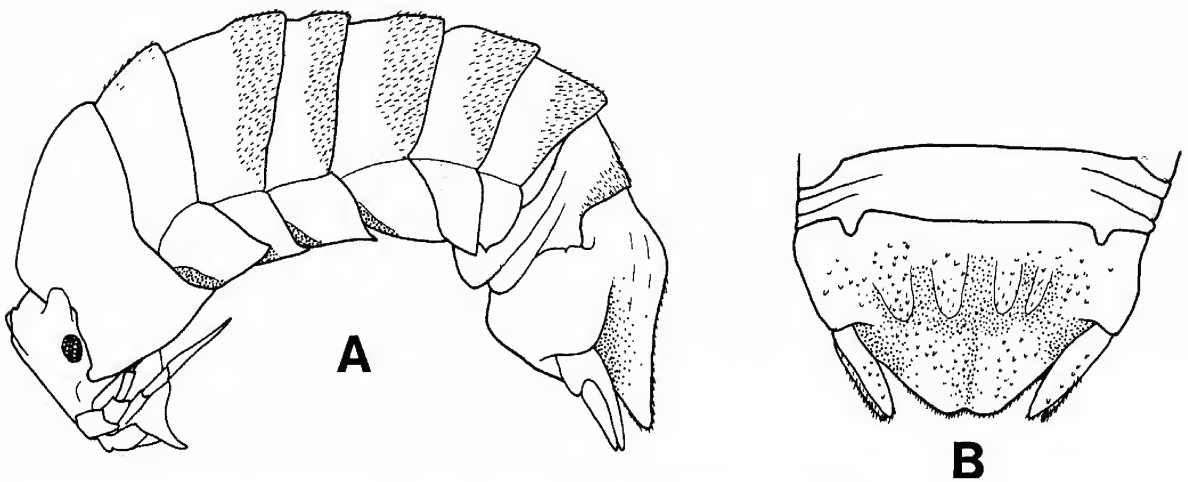

Figure 27. *Koremosphaera colonus* sp. nov. Female. A. lateral view; B, pleon and pleotelson, dorsal view.

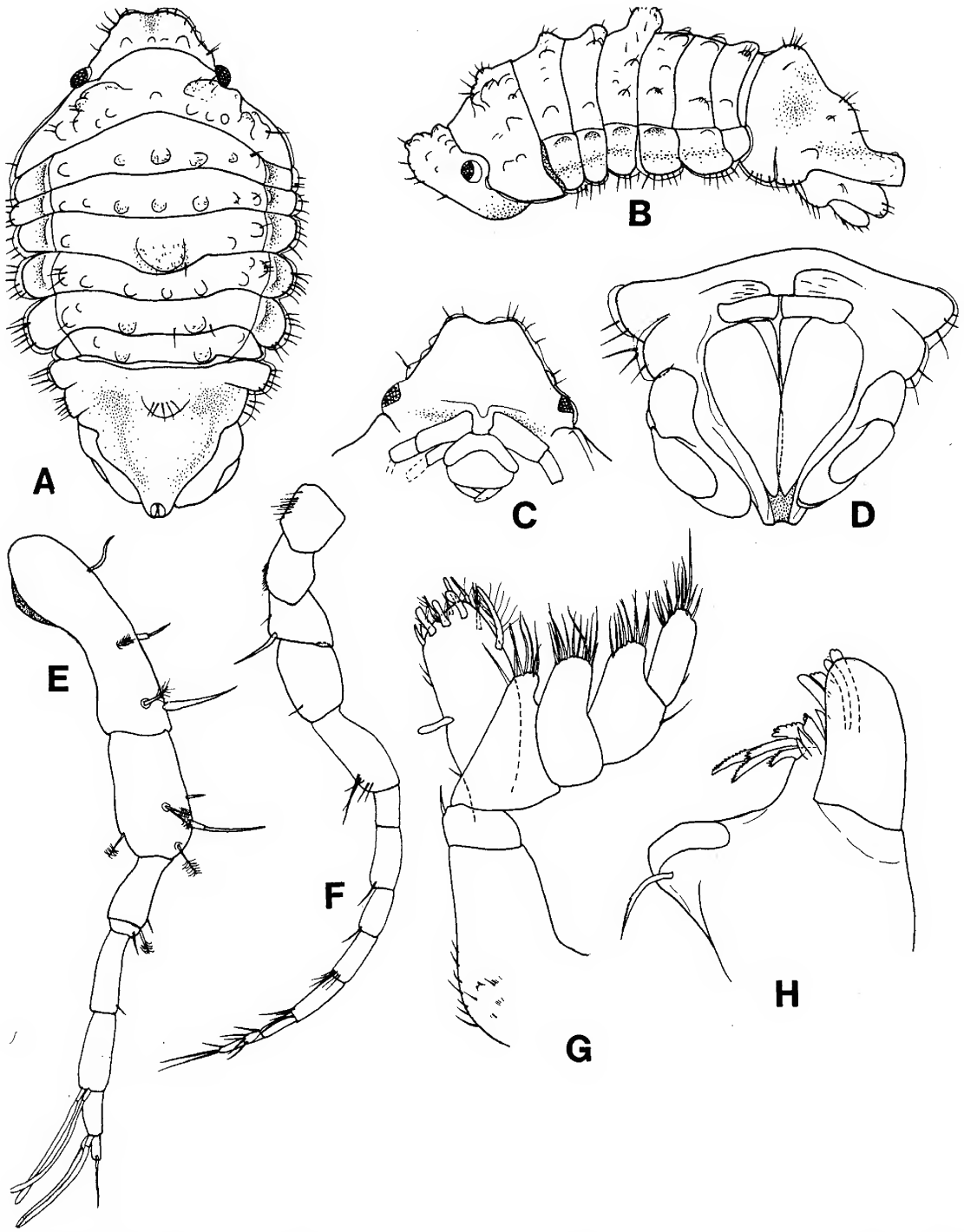

Figure 28. *Margueritta sandyi* sp. nov. A–D, holotype, remainder _ paratype. A, dorsal view; B, lateral view; C, frons, ventral view; D, pleon, posterior margin, ventral view; E, antennule; F, antenna; G, maxilliped; H, right mandible.

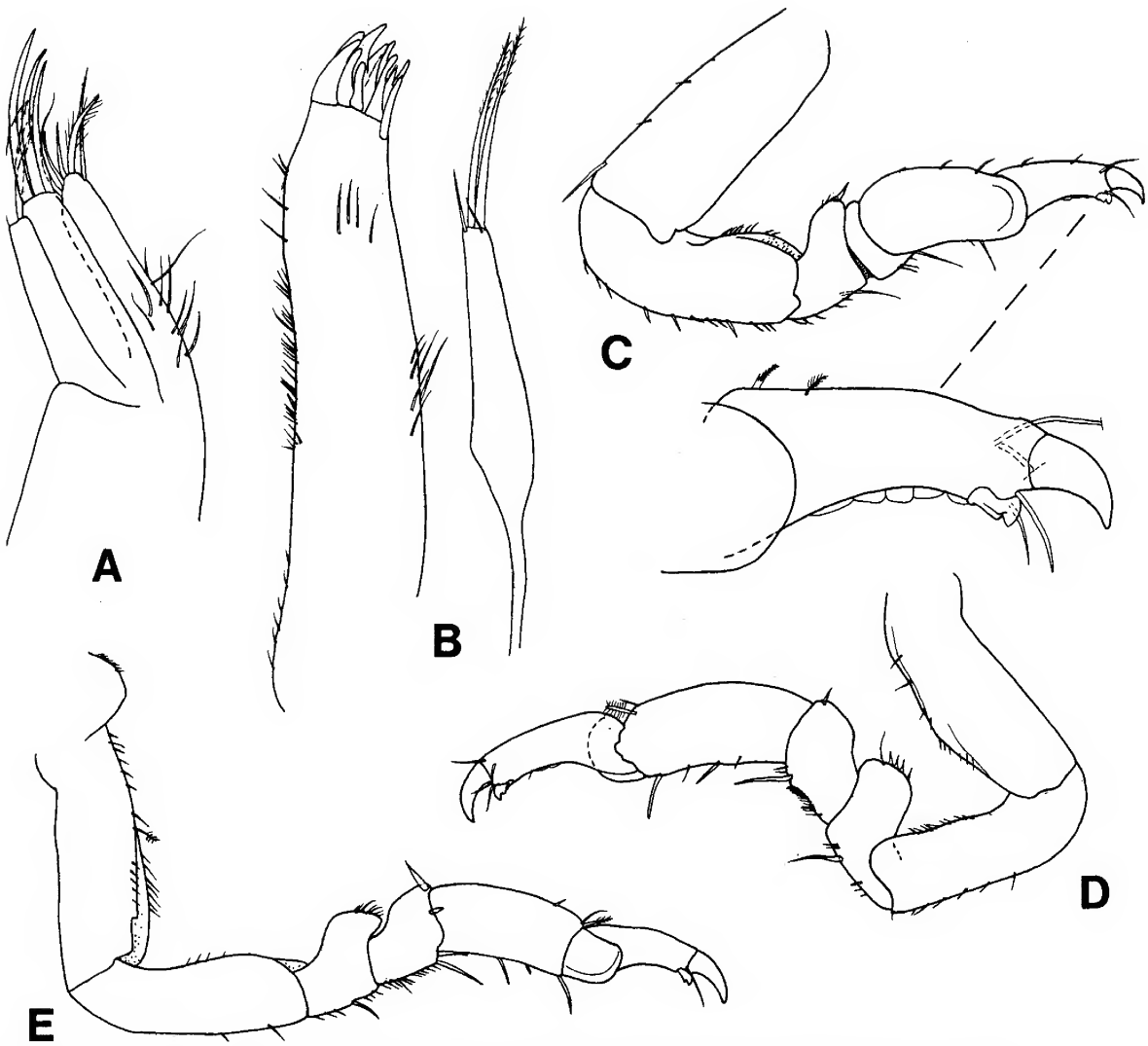

Figure 29. *Margueritta sandyi* sp. nov. Female paratype. A, maxilla; B, maxillule; C, pereopod 1; D, pereopod 2; E, pereopod 7.

tively, both rami distally narrowly rounded; endopod 0.6 as long as exopod, 2.5 times as long as greatest width, proximolateral margin weakly concave. Pleopod 2 exopod and endopod with c. 18 and 15 PMS respectively, those of distal margin of endopod submarginal; endopod twice as long as exopod. Pleopod 3 exopod and endopod with c. 17 and 14 PMS respectively. Pleopods 4 and 5 damaged, examined in situ, similar to that of the type species. Uropods not dissected and not examined in detail; rami flat, distally rounded, not extending to distal margin of pleotelson.

Male. Unknown.

Etymology. For Dr A.J. (Sandy) Bruce in recognition of his contribution to knowledge of the Crustacea, and to Caridea of the tropical Indo-Pacific and Australia in particular.

Distribution. Carnac I. and off Mullaloo, southern WA; on algae; 4–8 m.

Remarks. The numerous small dorsal bosses and the prominent median bosses on pereonite 4 and the pleotelson separate this species from its congener, *Margueritta sylviae*. Additional conspicuous points of differences are that in *M. sandyi* the body shape is narrower, the body itself is more strongly vaulted and the pleotelson extends posterior to the uropodal rami.

Moruloidea Baker

Moruloidea Baker, 1908: 150.—Baker, 1926: 276.—Hale, 1929: 292.—Harrison, 1984a: 383.—Harrison, 1984b: 268.

Vallentinia Stebbing, 1914a: 351 (name preoccupied).

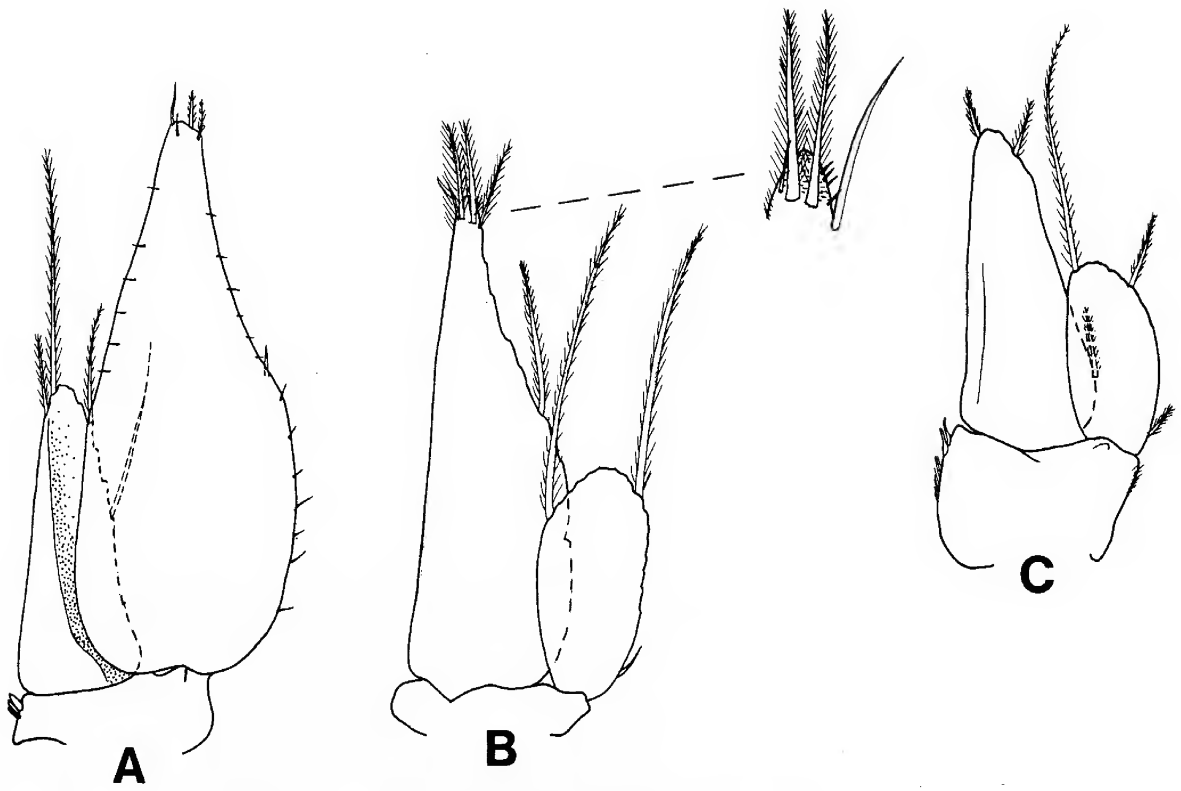

Figure 30. *Margueritta sandyi* sp. nov. Female paratype. A, pleopod 1; B, pleopod 2; C, pleopod 3.

Euvallentinia Stebbing, 1914b: 944 (replacement name).—Barnard, 1920: 374.—Nierstrasz, 1931: 218.—Loyola e Silva, 1974: 3.

Type species. Moruloidea lacertosa Baker, 1908, by monotypy.

Species included and distribution. Moruloidea lacertosa Baker, 1908; *M. darwinii* (Cunningham, 1871); *M. tasmaniae* (Baker, 1926); *M. tumida* (Harrison 1984b); *M. perionasus* sp. nov.; Gondwanan, southern coasts of Australia (WA, SA and Tas.), with one species from Atlantic coast of South America and Falkland Is (Harrison, 1984b).

Diagnosis of male. Body stout, about twice as long as greatest width, strongly vaulted; dorsal surfaces nodular. Pleotelson with or without median process; posterior margin with simple median notch and shallow exit channel. Coxae of pereonite 5 overlapping those of both pereonite 4 and 6. Pleon of 4 segments, segment 1 largely concealed by pereonite 7, segments 2–4 indicated by 2 distinct suture lines running to lateral margins of pleon. Antennule peduncle article 1 more than twice as long as article 2, articles 1 and 2 robust; article 3 slender, all articles collinear. Antenna articles 3 and 5 proportionally large, article 5 strongly reflexed. Mandible incisor unicuspid, or cusps indistinct; molar process prominent, crushing, provided with marginal scale teeth. Maxilliped palp articles 2–4 with distomesial angle moderately produced, mesial margins with numerous setae. Pereopods all ambulatory, pereopod 1 massive, robust, propodus inferior margin with or without lobe-like extension; pereopods 2–7 subsimilar, slender. Penes paired, close set; short, not reaching pleopod peduncles. Pleopods 1–3 both rami with PMS, both rami of subequal length; pleopod 1 with longitudinal axis of both rami weakly oblique, remaining pleopods with longitudinal axis of rami straight. Pleopod 2 with appendix masculina basally attached. Pleopods 3–5 exopods with complete suture. Pleopods 4 and 5 exopod and endopods usually with well-developed transverse thickened ridges; pleopod 5 endopod with 3 lobate scale patches. Uropods attached anterolaterally on pleon, exopod moderate to minute in size; both rami flat not extending beyond posterior margin of pleotelson.

Female. Sexual dimorphism weak; mouthparts not metamorphosed. Brood pouch of the type species of 3 pairs of oostegites on pereonites 2–4; brood housed in 4 pairs of internal pouches (Harrison, 1984). Antenna peduncle and pereopod 1 not as robust as in the male.

Remarks. The genus was revised by Harrison (1984b) who placed *Vallentinia* Stebbing, 1914a and *Euvallentinia* Stebbing, 1914b into synonymy.

The coxae of pereonite 5, antenna, antennule, pereopod and pleotelson of *Moruloidea* are similar to those of *Caecocassidias* Kussakin, 1967 (Brandt, 1998), *Cymodopsis* Baker, 1926, *Ceratocephalus* Woodward, 1877 (Bruce, 1994b),

Kranosphaera Bruce, 1992 and *Waiteolana* Baker, 1926 (Harrison 1984b). All have coxal plates 5 overlapping both anteriorly and posteriorly, robust pereopod 1 and the posterior margin with a simple shallow exit channel. Most (*Moruloidea*, *Caecocassidias*, *Ceratocephalus* and *Kranosphaera*) have the antenna with peduncle article 5 strongly reflexed and flat uropodal rami with the exopod varying from moderate to absent *Kranosphaera*. All species of *Cymodopsis* are inadequately described and the genus is poorly understood. Until *Cymodopsis* is revised the relationships of these genera to each other and to others will remain unclear.

The presence of a prominent pleotelson process in *Moruloidea perionasus* sp. nov. and additional data on *M. darwinii* (Brandt, 1998) necessitates modification of the diagnosis of Holdich (1984b). *M. darwinii* was described by Brandt (1998) as having lamellar rami on pleopods 4 and 5.

Moruloidea perionasus sp. nov.

Figures 31–34

Material examined. Holotype. Male (7.0 mm, immature), Thistle Cove, WA, 34°0′S, 122°12′E, 11 Apr 1984, 5.0 m, G.C.B. Poore and H.M. Lew Ton (NMV J39710).

Paratypes. **SA.** 2 males (6.2 immature, 5.5 adult [crushed] mm), north side of West I., Encounter Bay, 35°37′S, 138°36′E, 21 Mar 1985, 5 m, sediment at base of *Heterozostera*, G.C.B. Poore and H.M. Lew Ton (NMV J26202). Male (4.6 mm, immature), West I., Encounter Bay, 28 Jan 1990, under boulder fauna, S.A. Shepherd (SAM C5744).

Description of male. Body 1.8 times as long as greatest width (including anterior and posterior processes), widest at pereonites 1 and 5; dorsal surfaces of pereon, pleon and pleotelson granular. Head anterior margin strongly anteriorly produced to form anteriorly medially indented and bifid process, rostral process and frons distinctly ventral in position; head about 1.4 times as long as pereonite 1 in lateral view; pereonite 1 dorsally with ill-defined transverse band of tubercles, laterally with distinct boss and oblique thick longitudinal ridge; pereonites 2–4 narrower that pereonites 1 and 5, each with transverse row of small low tubercles; pereonite 5 wider than 4 and 6, coxae with prominent boss; pereonites 5–7 without distinct tubercles, pereonite 6 narrower than 7, pereonite 7 narrower than 6. Pleon posteriorly rounded in dorsal view, posterodorsal margin with low tubercles; sublateral pleonal 'keys' present. Pleotelson strongly vaulted, posterior margin with strongly produced dorsally arched process dorsal surface of which is provided with irregularly shaped nodules.

Antennule peduncle article 1 2.4 times as long as wide, about 8 times as long as article 2, anterior margin convex, posterior margin straight, angled obliquely distally; article 3 about as 0.5 times as long as article 1, about 3.6 times as long as wide, 4.0 times as long as article 2; flagellum 13-articled, extending to posterior of pereonite 1, about twice as long article 3. Antenna peduncle article 1 short, setose; articles 2 and 3 relatively elongate, article 2 2.5 times as long as wide, article 3 0.6 times as long as article 4, 1.7 times as long as wide; article 3, single long simple seta at superior distal angle; articles 2–4 collinear; article 4 0.8 times as long as article 5, 2.5 times as long as wide, superior margin with scale-setae; article 5 2.6 times as long as wide; flagellum stout, about 0.9 times as long as peduncle, extending to anterior of pereonite 2, with 11 articles.

Epistome anteriorly acute, with median constriction, surface irregular. Mandibles with both incisors unicuspid; left mandible with lacinia mobilis distally narrow, with 3 small cusps, spine row of 4 curved serrate spines; right mandible spine row of 1 broad-based bifid, multidigitate spine and 5 distally serrate spines; molar process round, crushing surface strongly ridged, marginally serrate; with basal group of 3 long plumose setae; palp not observed. Maxillule lateral lobe with 11 terminally acute serrate RS on gnathal surface, twelfth seta set between these. Maxilla lateral and middle lobes each with 6 curved finely serrate RS, mesial lobe with about 12 serrate and biserrate RS. Maxilliped endite lateral margin strongly convex, distal margin with 7 CP RS, 2 cactus setae, distomesial angle with 1 simple RS; distomesial margin with 3 large stout CP RS, increasing in size proximally; mesial margin of palp articles 2–5 with 9, 10, 12 and 8 long simple setae respectively; palp lateral margins without long setae, with 1 short simple seta at distal angle of article 3 and 4.

Pereopod 1 basis about twice as long as greatest width, approximately twice as long as propodus; ischium 1.2 times as long as propodus, 1.9 times as long as greatest width, superior margin with 1 proximal and 1 distal acute short simple RS; merus about 0.4 as long as ischium, 0.6 times as long as greatest width, superior distal angle with 2 acute simple RS inferior distal margin with 2 short bifid and 1 long acute simple; carpus inferior margin 1.2 times as long as merus, distally with 2 short bifid; propodus 1.5 times as long as greatest width, inferior lateral margin with 2 short biserrate RS, inferior margin with 3 stout bifid RS; dactylus 0.7 times as long as propodus, inferior margin with prominent serrate cuticular scales, secondary unguis simple, with distal point. Pereopod 2 basis 3.0 times as long as greatest width, margins with scattered scale-setae, superior margin with weak distal flange; ischium 0.75 times as long as basis, 2.8 times as long as greatest width, superior margin with 1 proximal and 1 distal acute short simple RS, merus about 0.7 times as long as ischium, superior distal angle with 2 short acute RS, inferior margin with 2 short stout acute setae and 1 long simple seta; carpus about as long as merus, superior distal angle with 1 simple seta, inferior margin with 2 acute simple setae, distal angle with 1 RS; propodus about as long as ischium, 1.6 times as long as carpus, superior distal angle with 1 simple and 1 palmate setae, inferior margin with 3 short stout acute RS; dactylus 0.5 times as long as propodus. Pereopods 5–7 similar, basis and ischium relatively longer than for pereopod 2, distal margins of carpus with more and longer RS. Pereopod 7 basis 4.4 times as long as greatest width, inferodistal angle with single simple seta, superior margin with widely-spaced small scale-setae; ischium 0.9 times as long as basis, 5.7 times as long as greatest width, superior margin with 1 proximal short acute RS, merus 0.4 times as long as ischium, superior distal margin with 1 acute RS, inferior distal angle with 1 stout acute seta; carpus about as long as merus, anterodistal angle with 3 long acute finely serrate and 1 simple RS, inferior margin with 2 stout short acute RS, inferior distal angle 3

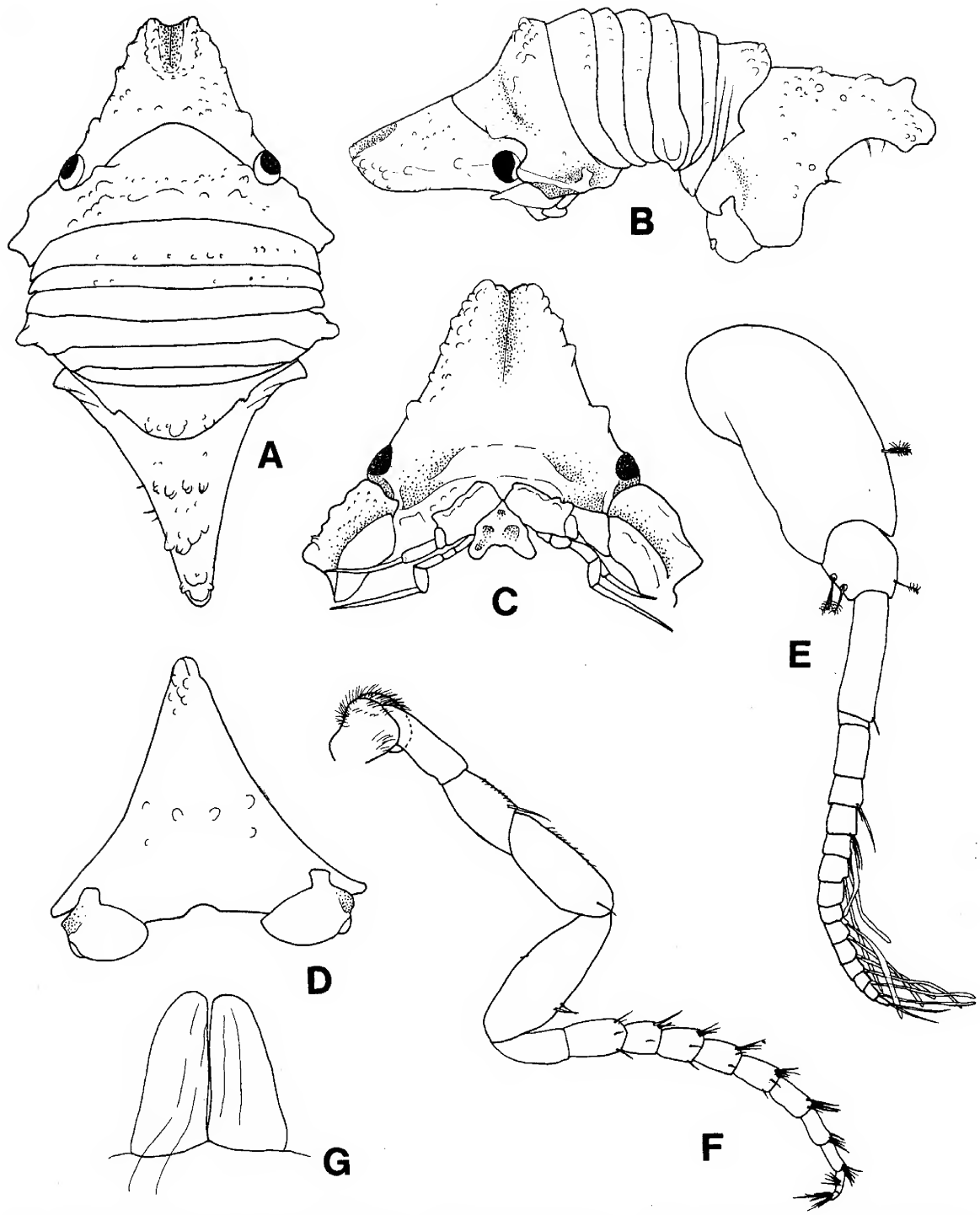

Figure 31. *Moruloidea perionasus* sp. nov. A–D, holotype, remainder male paratype, NMV J26202. A, dorsal view; B, lateral view; C, frons, ventral view; D, pleon, posterior margin, posterior view; E, antennule; F, antenna; G, maxilliped; H, penes.

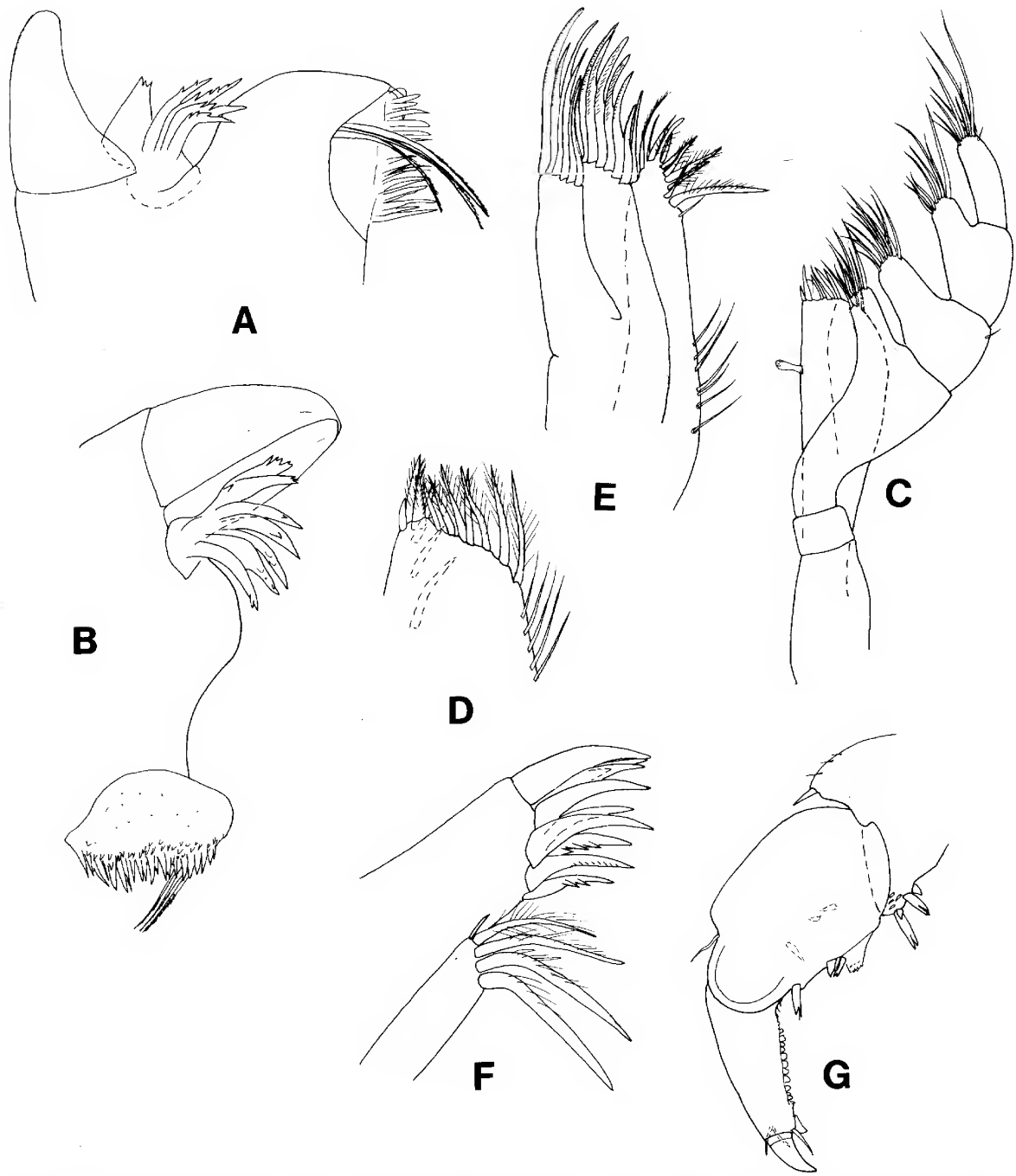

Figure 32. *Moruloidea perionasus* sp. nov. Male paratype, NMV J26202. A, right mandible; B, left mandible; C, maxilliped; D, maxilliped endite, distal margin; E, maxilla; F, maxillule; G, pereopod 1, propodus.

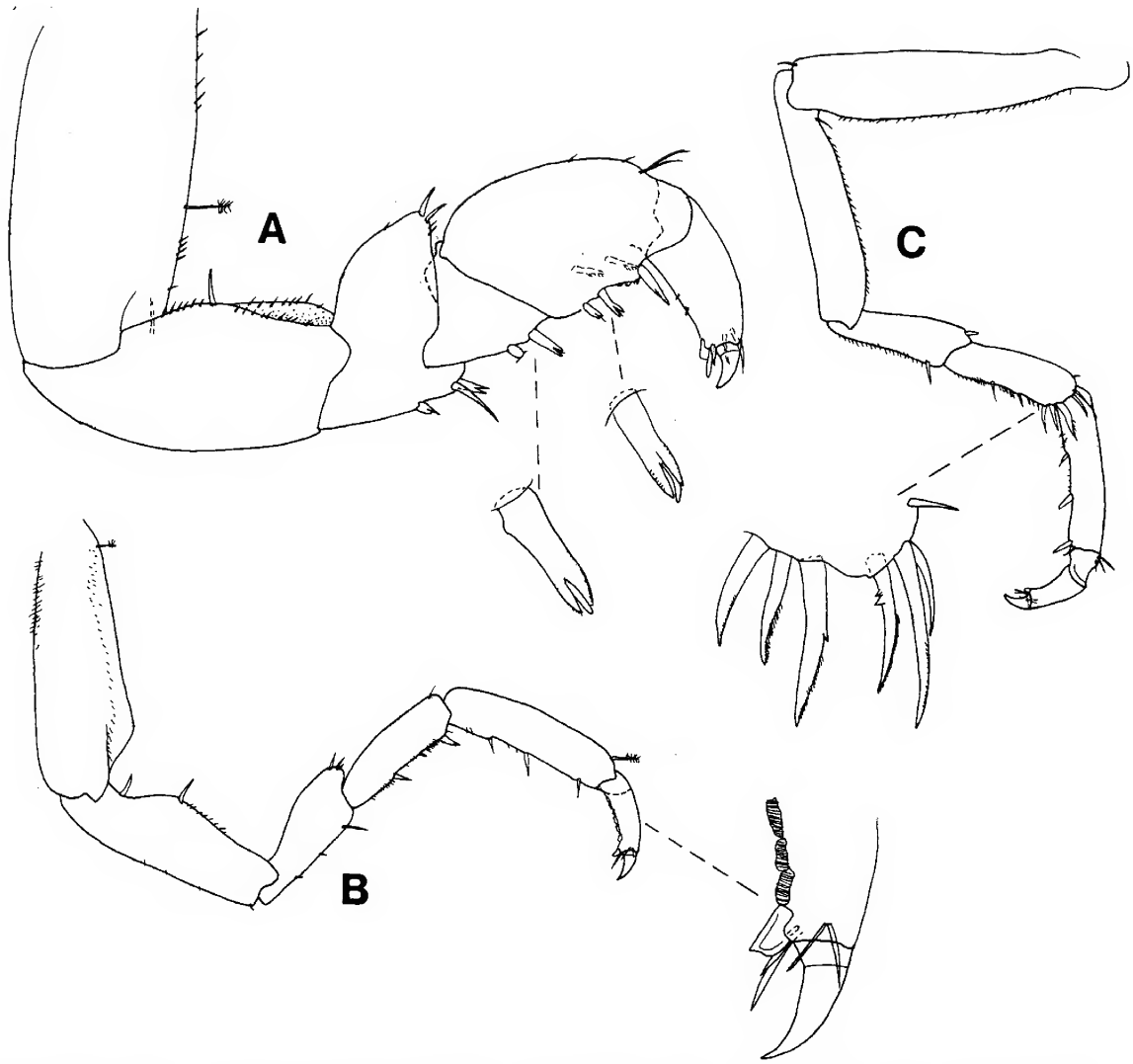

Figure 33. *Moruloidea perionasus* sp. nov. A, pereopod 1 holotype; remainder male paratype, NMV J26202: B, pereopod 2; pereopod 7.

finely biserrate RS; propodus 1.5 times as long as carpus, 0.7 times as long as ischium, superior distal angle with 2 palmate seta, inferior margin with 3 short stout acute RS; dactylus 0.4 times as long as propodus.

Penes mutually adjacent, twice as long as basal width; mesial margin straight, lateral margin angled mesially, apex bluntly rounded.

Pleopod 1 exopod and endopod with c. 17 and 16 PMS respectively, endopod mesial margin setulose; endopod subtriangular, 0.9 times as long as exopod, 1.5 times as long as greatest width; exopod lateral and mesial margins subparallel, distal margin rounded. Pleopod 2 exopod and endopod with c. 18 and 27 PMS respectively; appendix masculina 11 times as long as wide, slightly wider proximally, weakly sinuate, apex bluntly rounded. Pleopod 3 exopod and endopod with c. 50 and 18 PMS respectively. Pleopod 4 exopod lateral margin with 3 fine simple setae, distal part triangular, both margins with fine setae; endopod without setae. Pleopod 5 exopod with 2 distal bi-lobed scale patches, lateral margin with scattered minute simple setae; endopod with fine setae on distal margin only. Uropod peduncle dorsal surface densely covered with small nodules and minute hemispherical structures; endopod mesial margin straight, lateral margin with distal half angled mesially, distolateral margin subapically excavate; lateral margin entirely fringed with expanded cuticular scales; exopod small, 0.2 as long as endopod and peduncle, setin to anterolateral angle.

Female. Similar to male; ovigerous females not known.

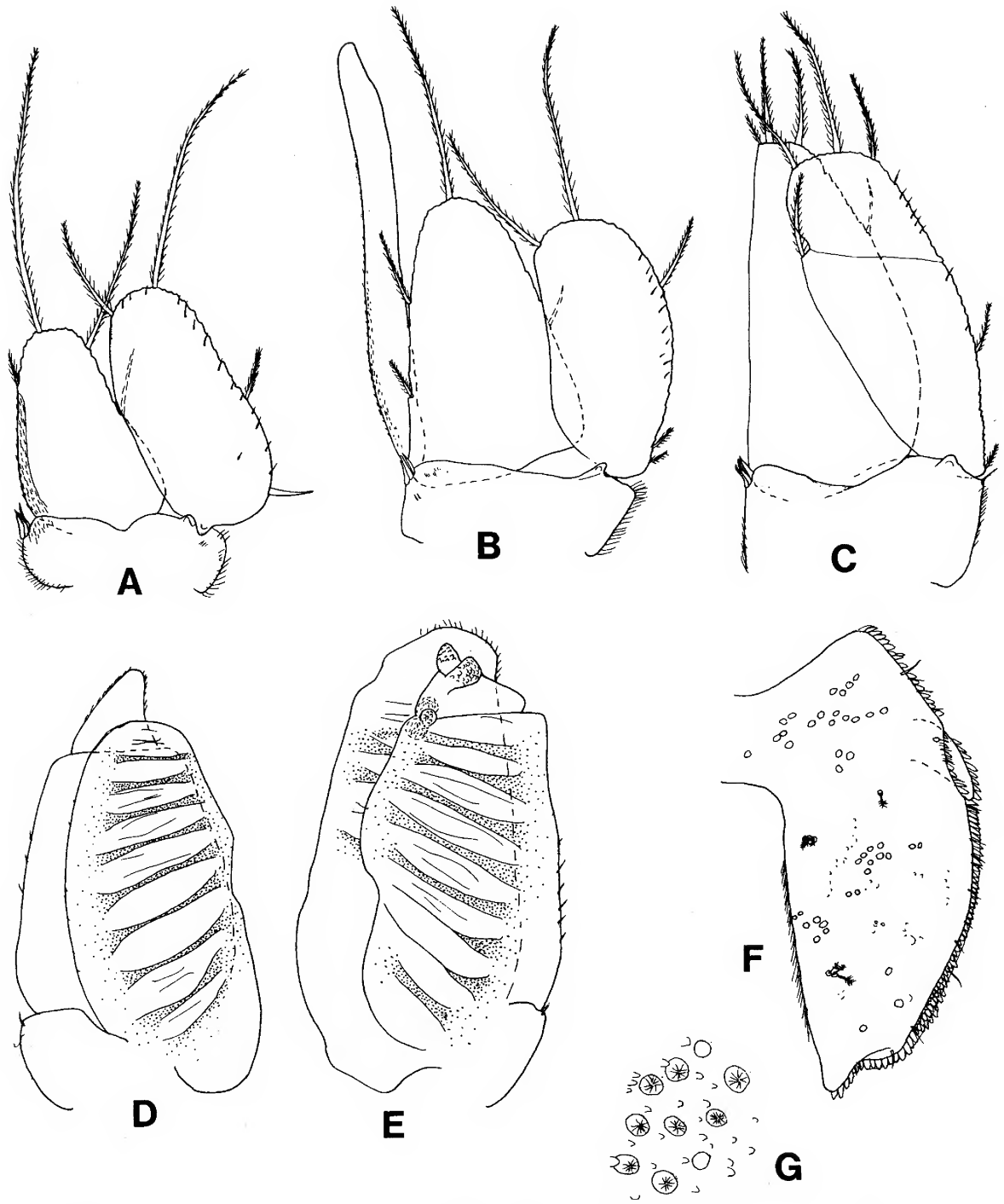

Figure 34. *Moruloidea perionasus* sp. nov. Male paratype, NMV J26202. A–E, pleopods 1–5; F, uropod; G, detail of uropod dorsal surface.

Etymology. From Greek *periosus* (immense) and *nasus* (nose), alluding the hugely projecting anterior margin of the head; noun in apposition.

Distribution. Thistle Cove, Great Australian Bight, WA, to Encounter Bay, SA; intertidal to 5 m.

Remarks. This remarkable spindle-shaped isopod is easily recognized by the prominent anterior cephalic and pleotelson projections. No other species in the genus has such ornamentation, and in addition the uropodal exopod is reduced to an inconspicuous small flat stub. These characters distinguish *Moruloidea perionasus* from all other sphaeromatids except perhaps *Bregmotypta* Bruce, 1994c, the only genus with similar cephalic and pleotelsonic projections. There are many differences at generic level, but in *Bregmotypta* the cephalic process is single and the pleotelson has two prominent bosses, while in *M. perionasus* the anterior process is doubled, and the posterior process is single and elongate.

Character states that support inclusion in *Moruloidea* are: antenna with expanded and reflexed articles 4 and 5; close-set, terminally rounded short, flat penial processes; appendix masculina arising basally, not distally narrowed and longer that ramus; pereopod 1 much more robust than pereopods 2–7, the propodus of which has a proximal extension; coxae 5 overlapping anteriorly and posteriorly; uropodal rami lamellar with exopod smaller than endopod. Other characters such as mouthparts and pleopods present a consistent appearance with other species of the genus.

The immature specimen was selected as holotype as it was the most intact specimen. The propodus of pereopod 1 in this juvenile lacks the prominent 'heel' of the adult male although that part of the inferior margin is weakly produced; the dactylus lacks the scales on the inferior margin.

Pedinura gen. nov.

Type species. Pedinura flindersia sp. nov., here designated.

Diagnosis. Pleotelson posterior margin entire, posteriorly produced, without exit channel, without ventral depression or groove. Antennule and antenna anteriorly positioned, peduncle articles 1 and 2 flattened and expanded; antennule peduncle articles 2 and 3 short, less than half as long as article 1; article 3 and flagellum collinear. Pereopods 1, 4–7 robust, pereopods 2 and 3 slender, pereopods 2 and 3 dactylus with prominent comb seta set against unguis. Pleopods 1–3 with rami of about equal length; pleopod 1 with axis of rami straight, not oblique. Pleopod 2 appendix masculina medially inserted, extending beyond distal margin of endopod. Pleopods 4 and 5 endopod and exopod with thickened ridges. Uropods ventrolateral in position, not visible in dorsal view; exopod minute, inserted into lateral margin, stub-like.

Description of male. Body elongate, 3 times as long as greatest width, moderately vaulted; dorsal surface smooth; lateral margins subparallel; unable to conglobate. Head weakly immersed in pereonite 1; rostral process minute or absent. Eyes small, lateral. Pereon segments without raised posterior margins. Coxal plates fused, without discernable suture, overlapping anterior over posterior. Membrana cingula absent. Pleon with 4 segments, pleonite 1 entire, 2 lateral sutures running to posterior margin of pleon. Pleotelson posterior margin produced as plate-like extension posterior to pleopod chamber; without foramen, without ventral exit channel or groove. Pleonal sternite present.

Antennule and antenna anteriorly positioned. Antennule peduncles not separated by epistome; peduncle articles 1 and 2 expanded, anteriorly flattened; plane of articles 1 and 2 of projecting ventrally; peduncle articles 2 and 3 short, article 3 shorter than article 2, together about 0.5–0.8 as long as article 1; flagellum of 4 articles, slightly shorter than combined lengths of articles 1 and 2. Antenna slender, peduncle articles 1 and 2 short, appearing fused, peduncle articles 4 longer than articles 3 and 5; flagellum as long as or slightly longer than peduncle.

Epistome wide, unornamented. Labrum unornamented. Mandible incisor 3- or 4-cuspid; left mandible with lacinia mobilis or without; molar process with or without marginal serrations; palp article 1 longest, 3 shortest. Maxillule with lateral lobe with 11 RS on gnathal surface, mesial lobe with 2 long and 1 short CP slender setae and 2 short simple seta (type species). Maxilla with all articles well developed; lateral and middle lobes with flat RS, mesial lobe with blunt and acute long RS, some of which are basally CP. Maxilliped endite distally with cactus and club setae, laterally with 1 long curved CP seta; palp articles not mesially produced, mesial margins with numerous setae, lateral margins without setae.

Pereopods 1, 5–7 robust, 2 and 3 slender; pereopods 2 and 3 dactylus with prominent pectinate secondary unguis opposing unguis, all other pereopods with prominent recurved trifid secondary unguI.

Penes short, not extending to pleopod peduncles; mutually adjacent or slightly set apart.

Pleopods 1 with axis of both rami straight, not oblique, about equal in length. Pleopod 1 not operculate, not indurate. Pleopod 2 appendix masculina medially attached. Pleopods 3 exopod with transverse suture, pleopods 4 with or without suture, pleopod 5 without. Pleopods 4 and 5 exopod and endopods with transverse thickened ridges; pleopod 5 endopod with 2 or 3 distal scale patches. Uropods endopod lamellar, exopod minute, stub-like, set into anterolateral margin of endopod.

Female. Antennule peduncle of type species articles 1 and 2 greatly expanded anteriorly. Brood pouch of overlapping oostegites arising on pereonites 2, 3 and 4. Mouthparts not metamorphosed.

Composition and distribution. Pedinura flindersia sp. nov.; *Pedinura mokari* sp. nov.; subtropical WA to Vic., Australia.

Etymology: A combination of Greek *pedinos* (flat, even), and *oura* (tail), alluding to the flattened pleotelson of the two species (feminine).

Remarks. The characters that best distinguish *Pedinura* are: the plate-like extension to the posterior margin of the pleotelson entirely lacking any exit channel, groove or depression; ventral uropods (not visible in dorsal view) with a minute exopod;

expanded articles to antennule peduncle articles 1 and 2; and the appendix masculina being mesially inserted and extending beyond the distal margin of the exopod.

Pedinura resembles *Amphoroidea* Milne Edwards, 1840, *A. angustata* Baker, 1908 being the most similar. Although *Amphoroidea* and its species have not been fully described, the two genera can immediately be separated by *Amphoroidea* having anterolateral uropods, prominent in dorsal view and extending well beyond the posteriorly narrowed pleotelson. Further points of distinction include the appendix masculina being basal (mesial in *Pedinura*), pleopod 1 endopod distinctly triangular with an indurate mesial margin, and the uropod with both rami large and lamellar.

Cassidinopsis Milne Edwards, 1840 is similar (Brandt, 1998) but in that genus the antennule peduncular articles 1 and 2 are not expanded, pereopod 2 lacks the pectinate robust seta opposite the dactylus, and most notably the uropods are lateral (not ventral) and extend well to the posterior of the pleotelson which is not posteriorly produced.

Pedinura flindersia sp. nov.

Figures 35–39

Material examined. Holotype. Male (3.8 mm), "The Hotspot" reef, 5 n. miles W of north end of Flinders I., SA, 33°40.50′S, 134°22′E, 19 Apr 1985, 17 m, assorted red algae, S. Shepherd (NMV J39728).

Paratypes. **Vic.** 3 females (immature 2.0, 2.2, 2.3 mm), 2 mancas (1.1, 1.2 mm), Whalers Point Lighthouse, Portland, 38°20.5′S, 141°37.5′E, 1 May 1988, 10 m, brown algae from boulder bottom, R.T. Springthorpe and P.B. Berents (AM P50944). Male (5.0 mm), 38°40′S, 145°35′E, 6 Mar 1982, 0 m, rocky, G.C.B. Poore (NMV J26380). Female (4.2 mm), 2 mancas (1.5, 2.5 mm), 500 m offshore, 1 km E of Harmers Haven, 38°34′S, 145°40′E, 6 Mar 1982, 11 m, rocky, C. Larsen and G. Barber (NMV J26377). Male (4.1 mm), female (3.0 mm), 300 m offshore, E of Harmers Haven, 38°34′S, 145°40′E, 6 Mar 1982, 6 m, rocky, R.S. Wilson and C. Larsen (NMV J26381). Male (5.5. mm), female (3.5 mm), 50 m offshore, E side of South Point, Twin Reefs, 38°41′S, 145°39′E, 4 Mar 1982, 11 m, rocky, C. Larsen, G. Barber and R.S. Wilson (NMV J26383). Male (4.2 mm), The Oaks, Bunurong Coast, 38°40′S, 145°38′E, 5 Mar 1982, rock, G.C.B. Poore (NMV J26375). Male (3.1 mm), Eagles Nest, Venus Bay, 38°40′S, 145°40′E, 5 Mar 1982, rock, G.C.B. Poore (NMV J26378). Female (5.2 mm), NW side of Henty Reef, Mounts Bay, 38°47.0′S, 143°40.5′E, 3 May 1988, 18 m, red algae on boulder, R.T. Springthorpe and P.B. Berents (AM P50946). **SA.** 2 males (3.3 dissected, 3.4 mm), 6 females (ovigerous 3.7, 4.4, 5.0 dissected, non ovigerous 2.9, 3.0, 3.1 mm), immature (2.4, 2.6, 2.8, 3.0, 3.8 mm), mancas (1.7, 1.7, 1.8 mm), same data as holotype (NMV J39721). 2 males (3.0, 3.2 mm), 2 females (3.4, 3.6 mm), Snapper Point, Beachport, 37°29.3′S, 139°59.6′E, 14 May 1990, 6.0 m, brown algae, on limestone reef, G.C.B. Poore (NMV J26231). **WA.** Female (3.0 mm), Seven Mile Beach, N of Dongara, 29°12′S, 114°53′E, 24 Apr 1986, 1 m, *Amphibolus* epiphytes, G.C.B. Poore and H.M. Lew Ton (NMV J26173). Female (4.1 mm), Cliff Head, S of Dongara, 29°32′S, 114°59′E, 22 Apr 1986, 1 m, red algae on limestone, G.C.B. Poore and H.M. Lew Ton (NMV J26158). Female (3.9 mm), off jetty, Green I., Rottnest I., 32°01′S, 115°30′E, 21 Dec 1983, 1 m, mixed algal turf on rock, R.T. Springthorpe (AM P50943).

Other material, unmeasured. **Vic.** Bay of Islands, 38°35.0′S, 142°49.5′E, 2.5 m, red algae (AM P50945). Portland, 38°24′S, 141°40.5′E, 23m, *Herdmania momus* with encrusting sponge and red algae (AM P50947). **SA.** Topgallant I., Investigator Group, 33°43′S, 133°36.60′E, 20 m, on *Cystophora* and *Plocamium* (NMV J39730). "The Hotspot" reef, N end of Flinders I., 33°40.50′S, 134°22′E, 12 m, assorted algae (NMV J39706); 21 m, red algae (NMV J39722). 7, 2.3 n. miles W of Tiparra Light, Tiparra Reef, Tiparra Bay, 15 Mar 1985, 10 m, red algae (NMV J39727). **WA.** Port Denison Beach, Dongara, 5 m, red algae, mainly *Laurencia* (NMV J39704).

Description of male. Body about 3.2 times as long as greatest width, lateral margins subparallel, pereonites of subequal width, pereonite 4 marginally widest; dorsal surfaces smooth, unornamented. Head anterior margin without transverse ridge, rostral process not visible in dorsal view. Head and pereonites 1 subequal in length in dorsal view, pereonites 1>2=3<4=5>6>7. Pleotelson posterior margin smoothly rounded.

Antennule peduncle article 1 1.4 times as long as proximal width, about 2.6 times as long as article 2; article 2 flattened, about as long as wide, anterior margin with single small seta, posterodistal angle with 2 small setae; article 3 about half as long as article 2; flagellum 4-articled, extending to anterior of pereonite 1, about 0.4 times as long article 3. Antenna peduncle articles 1 and 2 about as long as combined lengths of article 3 and 4; article 4 about as long as article 5, about 1.3 times as long as wide; flagellum about equal in length to peduncle, extending to anterior margin of pereonite 2, with 6 articles.

Epistome smooth, narrow, laterally encompassing labrum, anteriorly forming distinct point. Mandible incisor with 3 cusps; lacinia mobilis absent; spine row of 3 serrate curved spines, on right mandible with additional broad-based multidigitate spine; molar process appearing largely smooth, without serrate margins or ridged surfaces; palp article 1 longest, without setae; article 2 with 3 biserrate setae, article 3 with 4 biserrate setae, terminal seta being largest. Maxillule mesial lobe with 2 long and 1 shorter weakly CP and 1 short simple seta; lateral lobe with 9 peripheral simple RS on gnathal surface, eleventh seta set between these. Maxilla lateral lobe and middle lobe each with 4 curved flat simple RS respectively, mesial lobe with about (not clearly observed) 6 RS, variously serrate. Maxilliped endite extending about half way along palp article 3, distal margin with 1 conical RS, 3 rounded RS, 1 cactus RS and laterally with 2–3 slender CP RS; palp articles 2–5 with about 4, 9, 8 and 11 setae respectively.

Pereopod 1 basis about 1.6 times as long as greatest width, about 1.1 times long as propodus; ischium 0.6 times as long as basis, 1.8 times as long as greatest width, inferior surfaces with abundant microtrichs; merus about 0.7 times as long as ischium, 0.7 times as long as greatest width; carpus (inferior margin) 0.7 as long as merus, 0.8 times as long as wide; propodus 1.5 times as long as ischium, 1.9 times as long as greatest width, inferior margin with 2 biserrate RS, inferodistal margin with 2 biserrate RS and 2 short simple setae adjacent to base of dactylus; dactylus 0.4 times as long as propodus, unguis strongly recurved, inferior margin with few small cuticular scales, secondary unguis recurved with 2 basal cusps. Pereopod 2 with all articles slender; basis about 3.1 times as long as greatest width, about as long as propodus; ischium 0.8 times as long as basis, 2.5 times as long as greatest width, inferodistal angel with single seta; merus about 0.7 times as long as ischium, 1.7 times as long as greatest width, superior distal

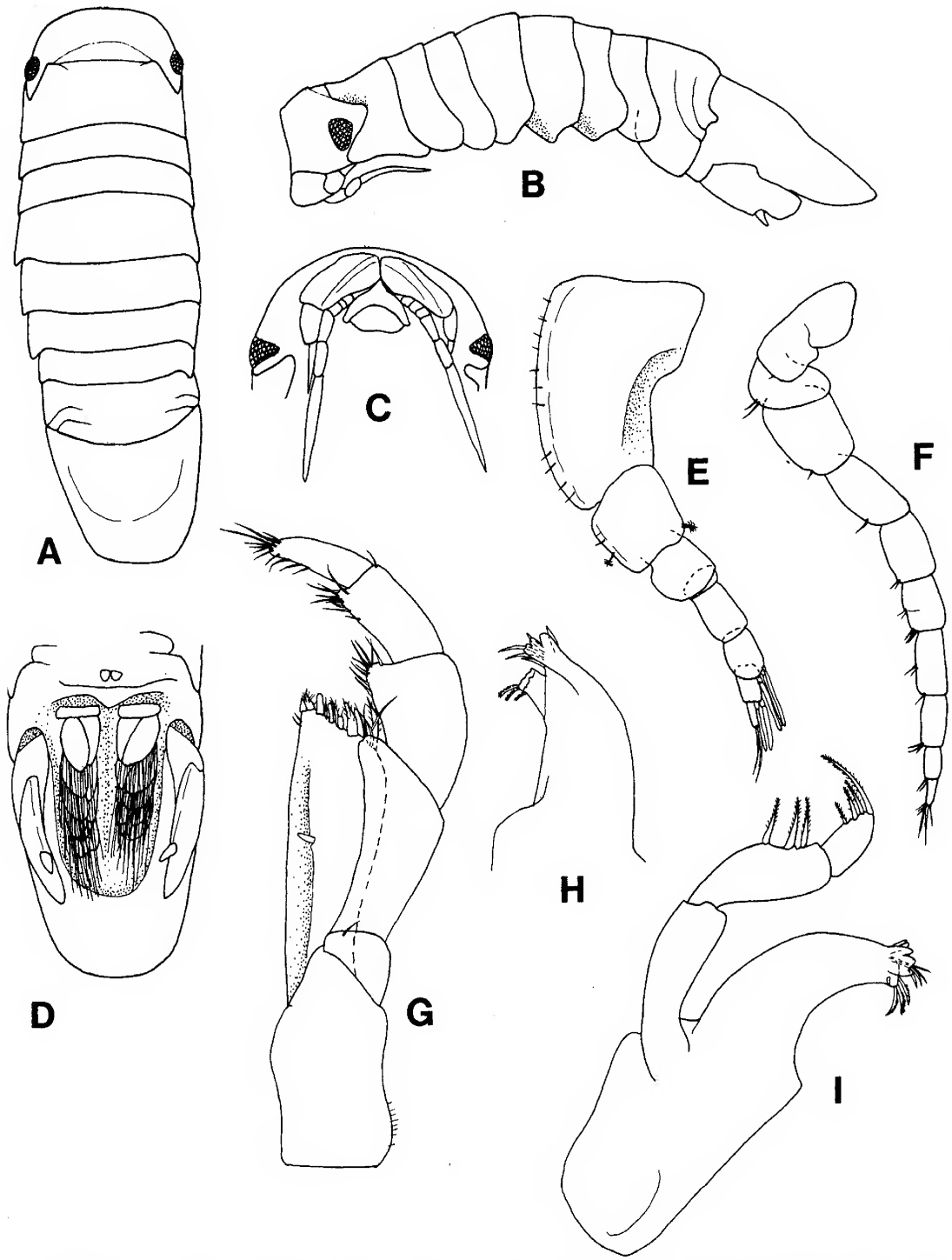

Figure 35. *Pedinura flindersia* sp. nov. A–D, holotype, remainder male paratype NMV J39721. A, dorsal view; B, lateral view; C, frons, ventral view; D, pleon and pleotelson, ventral view; E, antennule; F, antenna; G, maxilliped; H, left mandible; I, right mandible.

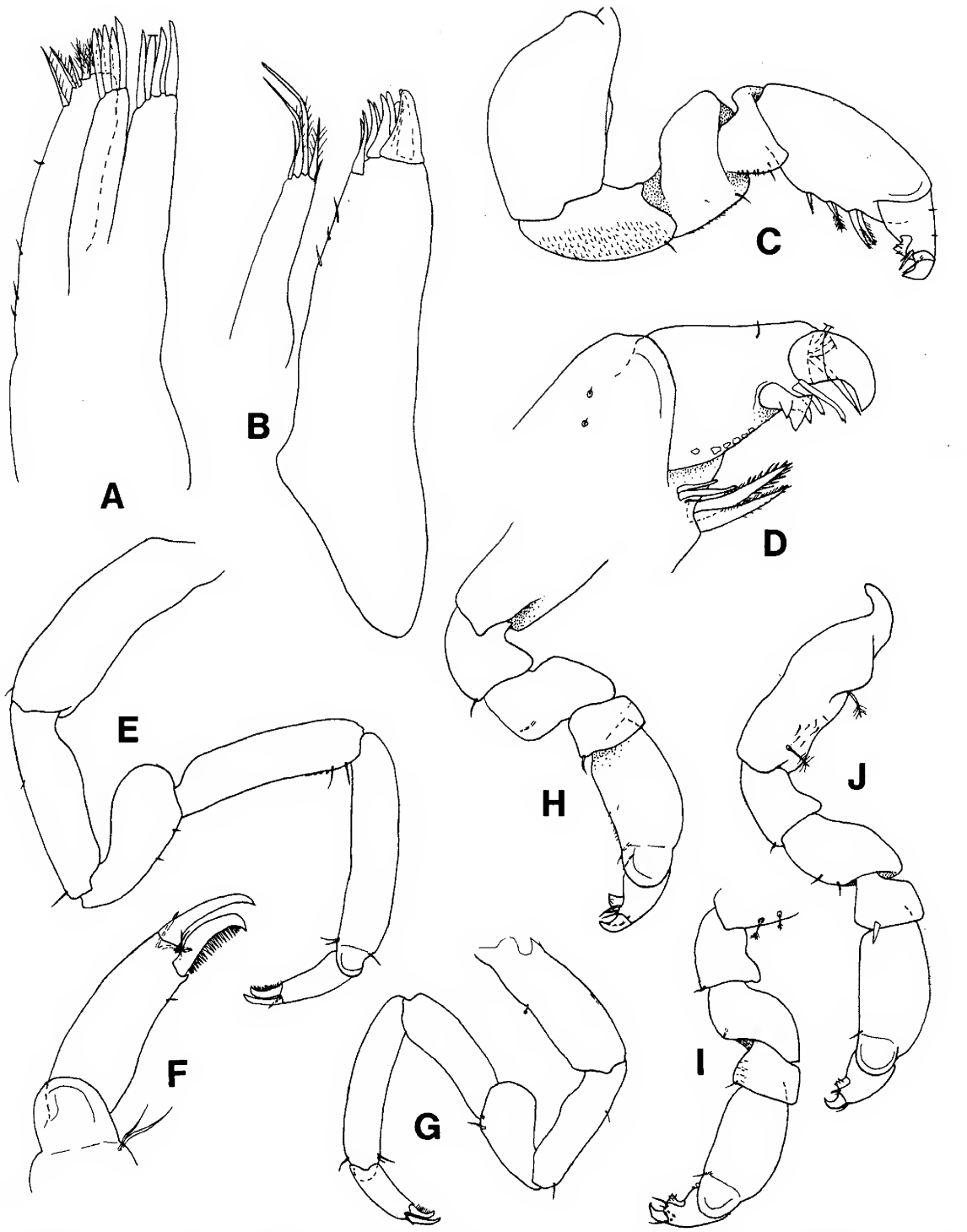

Figure 36. *Pedinura flindersia* sp. nov. All figs male paratype NMV J39721. A, maxilla; B, maxillule; C, pereopod 1; D, pereopod 1, dactylus; E, pereopod 2; F, pereopod 2, dactylus; G, pereopod 3; H, pereopod 6; I, pereopod 4; J, pereopod 7.

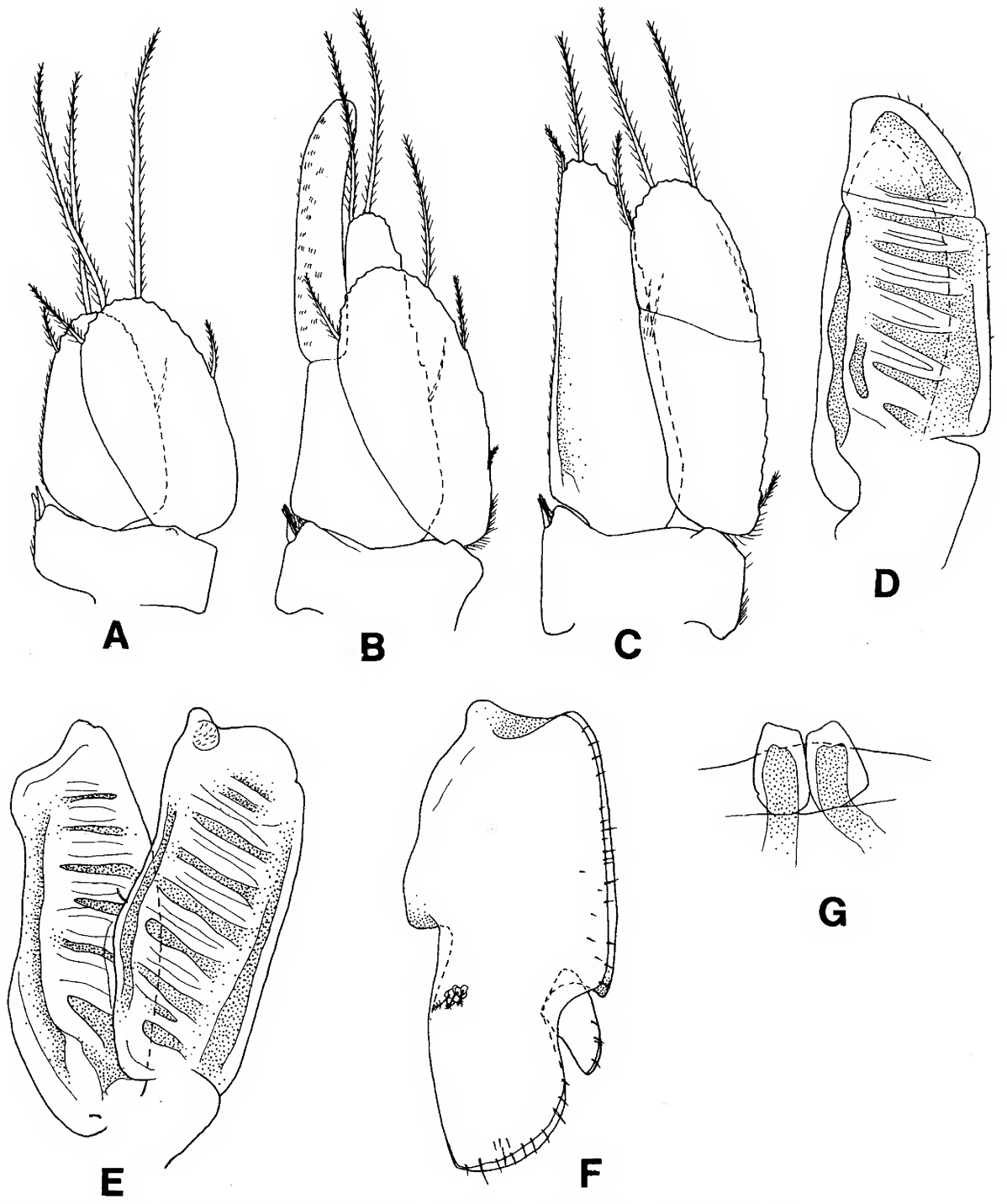

Figure 37. *Pedinura flindersia* sp. nov. All figs male paratype NMV J39721. A–E, pleopods 1–5; F, uropod; G, penes.

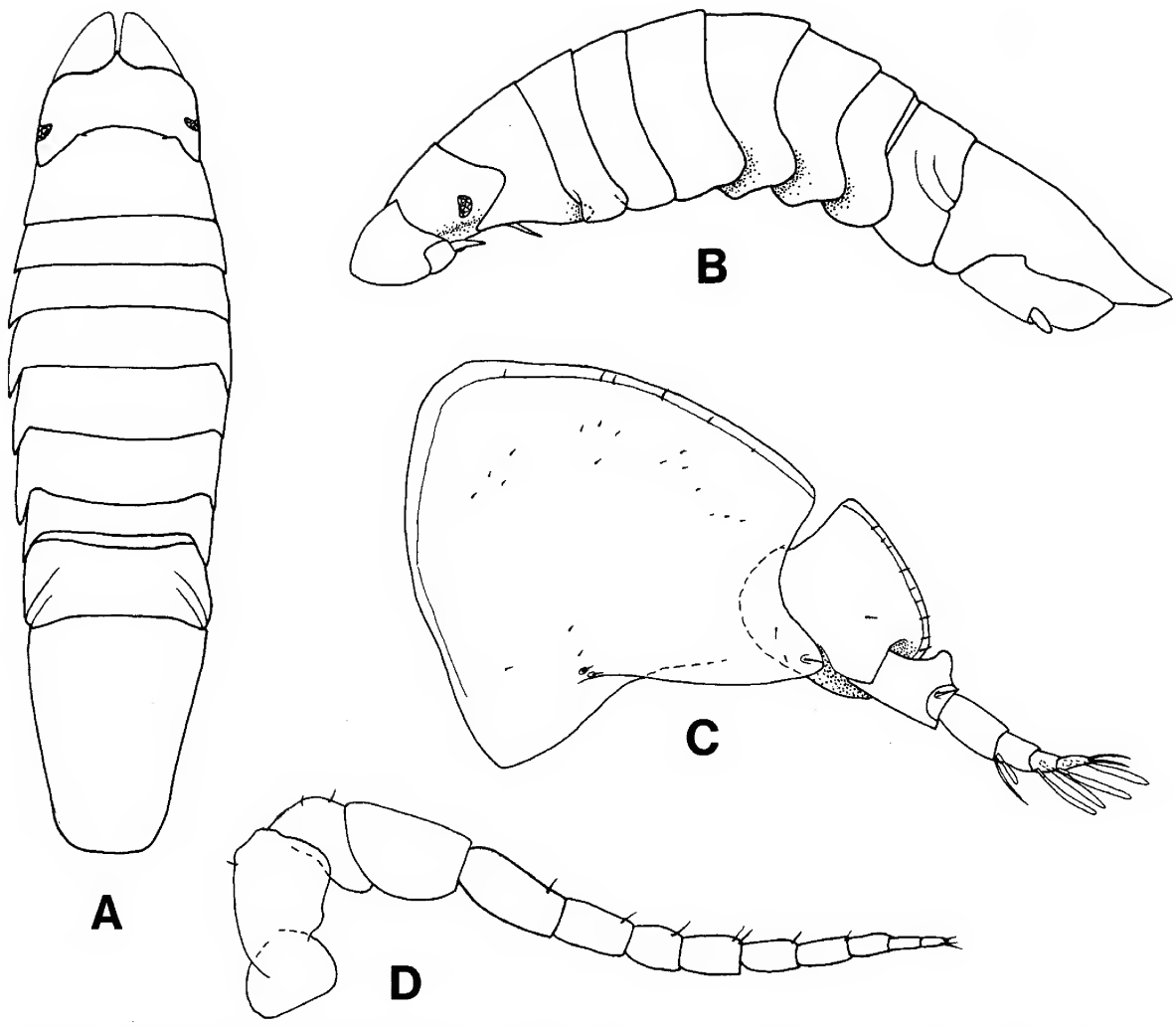

Figure 38. *Pedinura flindersia* sp. nov. All figs female paratype NMV J39721. A, dorsal view; B, lateral view; C, antennule; D, antenna.

margin strongly convex; carpus 1.7 as long as merus, 4 times as long as wide; propodus 1.3 times as long as ischium, 5.3 times as long as greatest width; dactylus 0.4 times as long as propodus, unguis slender apically falcate, secondary unguis flat and strongly pectinate extending alongside unguI. Pereopod 3 similar to 2, but a little more robust. Pereopods 4–7 similar to pereopod 1, but carpus quadrate rather than subtriangular, propodus inferior margin without biserrate RS; all pereopods without trifid and biserrate setae. Pereopod 7 basis with proximal flange; carpus distal margin with single simple acute RS.

Penial processes separate, adjacent, about 1.7 times as long as basal width, quadrate in shape, distal margin weakly oblique, feebly indented.

Pleopod 1 exopod and endopod with c. 14 and 12 PMS respectively; rami of similar size, endopod 0.9 as long as exopod, 1.8 times as basal width, lateral margin converging slightly to rounded distal margin; exopod 2.0 time as long as greatest width, margins subparallel, distal margin broadly rounded. Pleopod 2 exopod and endopod with c. 18 and 12 PMS respectively, pleopod 2 endopod 1.2 times as long as exopod, 2.3 times as long as greatest width, lateral margin strongly recessed at insertion point of appendix masculina; appendix masculina attached about half way along mesial margin, lateral surface with abundant microtrichs, about 5.3 times as long as wide, 0.8 times as long as endopod, apex bluntly rounded. Pleopod 3 exopod and endopod with c. 24 and 11 PMS respectively; both rami elongate, endopod very slightly (1.06) longer than exopod, slender, 2.9 times as long as greatest width, proximal lateral margin convex. Pleopod 4 both rami with prominent ridges, exopod lateral margin with fine setae, exopod suture incomplete. Pleopod 5 both rami with prominent

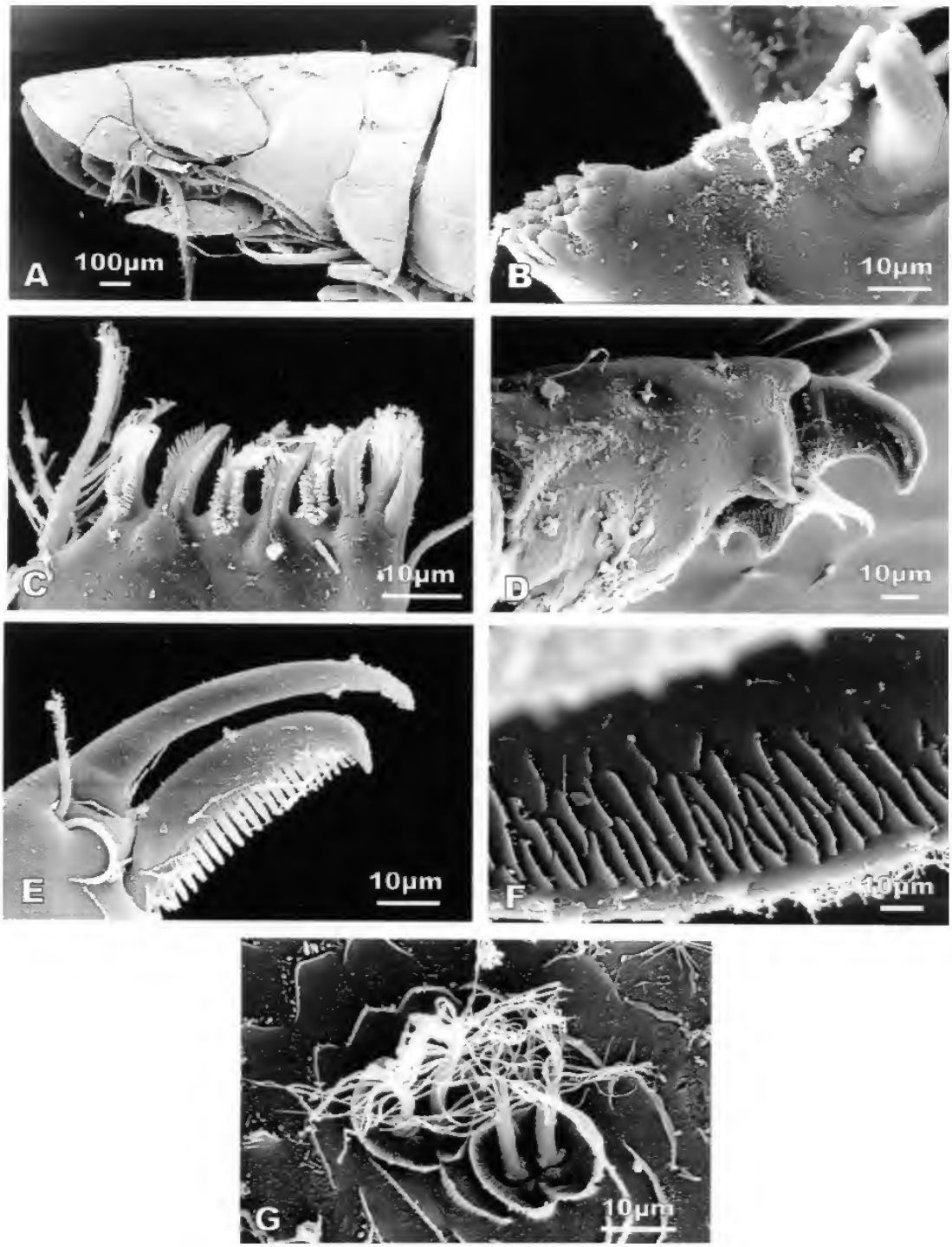

Figure 39. *Pedinura flindersia* sp. nov. SEMs. Female, 'The Hotspot' reef, Flinders I., NMV J39722. A, anterior, lateral view; B, mandible; C, maxilliped, distal margin; D, pereopod 1 dactylus; E, pereopod 2, pectinate robust seta on propodus; F, uropod lateral margin; G, sensory setae, uropods.

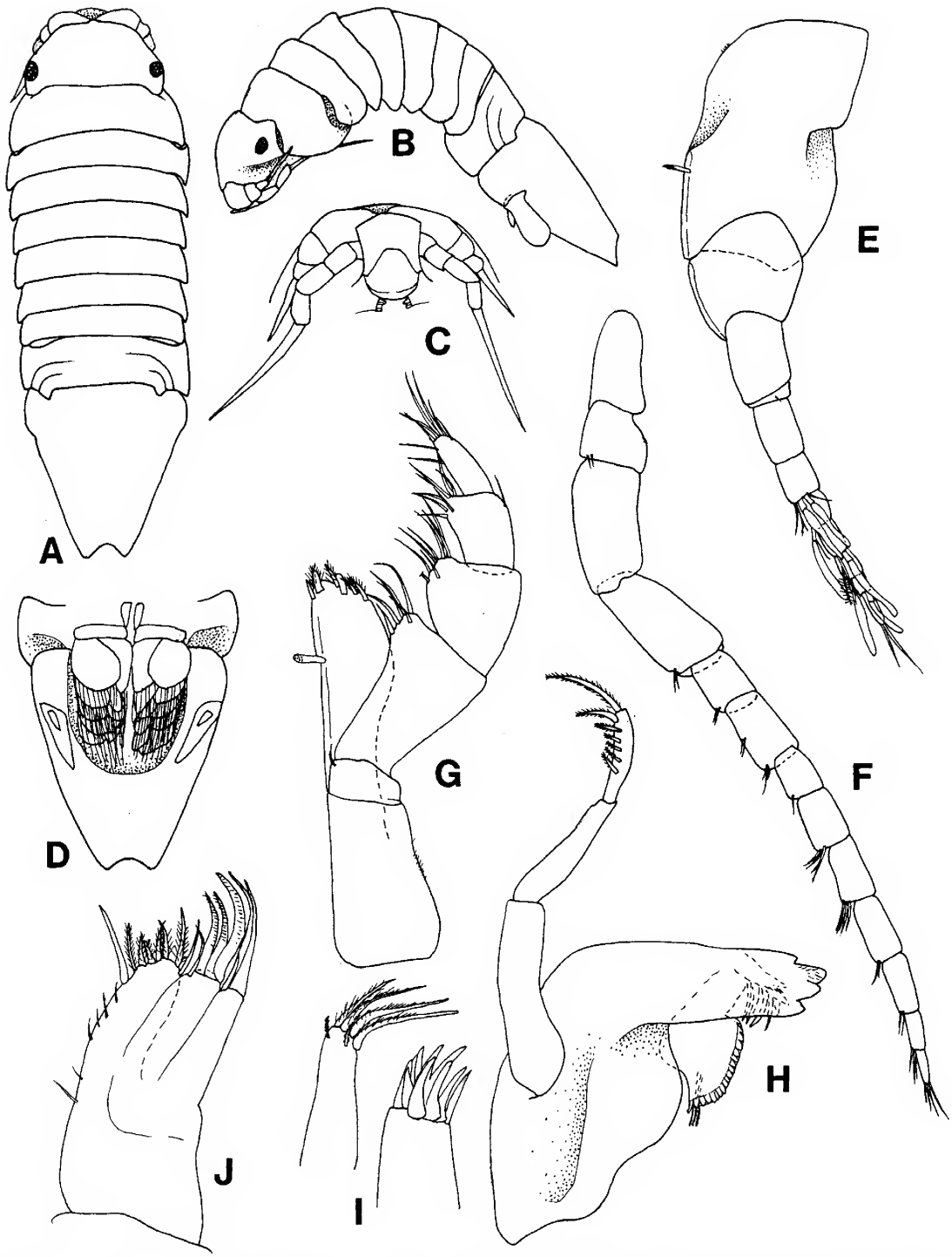

Figure 40. *Pedinura mokari* sp. nov. A–D, holotype, remainder male paratype NMV J39721. A, dorsal view; B, lateral view; C, frons, ventral view; D, pleon and pleotelson, ventral view; E, antennule; F, antenna; G, maxilliped; H, left mandible; I, maxilla; J, maxillule.

ridges; exopod with 2 distal scale patches, and transverse absent. Uropod rami flattened, margins provided with mebrana cingula; exopod inserted into lateral margin at about one-third from posterior margin, 02 times as long as fused endopod, anterior margin convex, posterior weakly concave, distal margin narrowly rounded; endopod anterolateral margin straight, posterolateral part subtruncate, mesial margin weakly convex; broadly rounded, proximomesial cluster of 3 sensory setae.

Female. Anterior body outline includes conspicuously expanded antennule peduncular articles 1; rostral point evident in dorsal view; eyes smaller than in males. Antennule peduncle article 1 0.8 times as long as mesial width, about 2.6 times as long as article 2, anteriorly produced, plate-like; article 2 flattened, about as long as wide, anterior margin produced, anteromesial angle at right angles, forming continuous margin with peduncular article 1; article 3 anterior margin with small distinct anterior boss. Antenna as for the male.

Size. Males 3.1–5.5 mm, ovigerous females 3.7–5.0 mm, non-ovigerous females 2.9–5.2 mm; juvenile (sex indeterminate) 2.4–3.8 mm; mancas 1.1–2.5 mm.

Etymology. From the type locality; noun in apposition.

Distribution. Vic. (Bunerong), SA, WA (Rottnest I., Seven Mile Beach, Dongara); intertidal to 21 m; mainly on red and brown algae, specifically on *Cystophora, Laurencia* and *Plocamium.*

Remarks. This species is distinguished by the posterior margin of the pleotelson being widely subtruncate and without a median indentation. Further distinguishing characters include the strongly expanded antennule peduncle articles 1 and 2, the anteriorly acute epistome not visible in dorsal view, robust pereopods and the uropod exopod being set distally on the endopod.

Pedinura mokari sp. nov.

Figures 40–42

Material examined. Holotype. Male (3.2 mm), Snapper Point, Beachport, SA, 37°29.3′S, 139°59.6′E, 14 May 1990, 6.0 m, brown algae etc., G.C.B. Poore and R.S. Wilson (NMV J39714).

Paratypes. **Vic.** Male (3.1 mm), wharf at Port Campbell, 38°37.5′S, 142°59.5′E, 8 Apr 1988, 5 m, wood and encrusting algae from wharf pile, R.T. Springthorpe and P.B. Berents (AM P50942). Male (3.2. mm), ?female (2.6 mm), juv. (1.8, 2.0 mm), 50 m offshore, E side of South Point, Twin Reefs, 38°41′S, 145°39′E, 4 Mar 1982, 11 m, rocky, C. Larsen, G. Barber and R.S. Wilson (NMV J26228). ?female (3.0

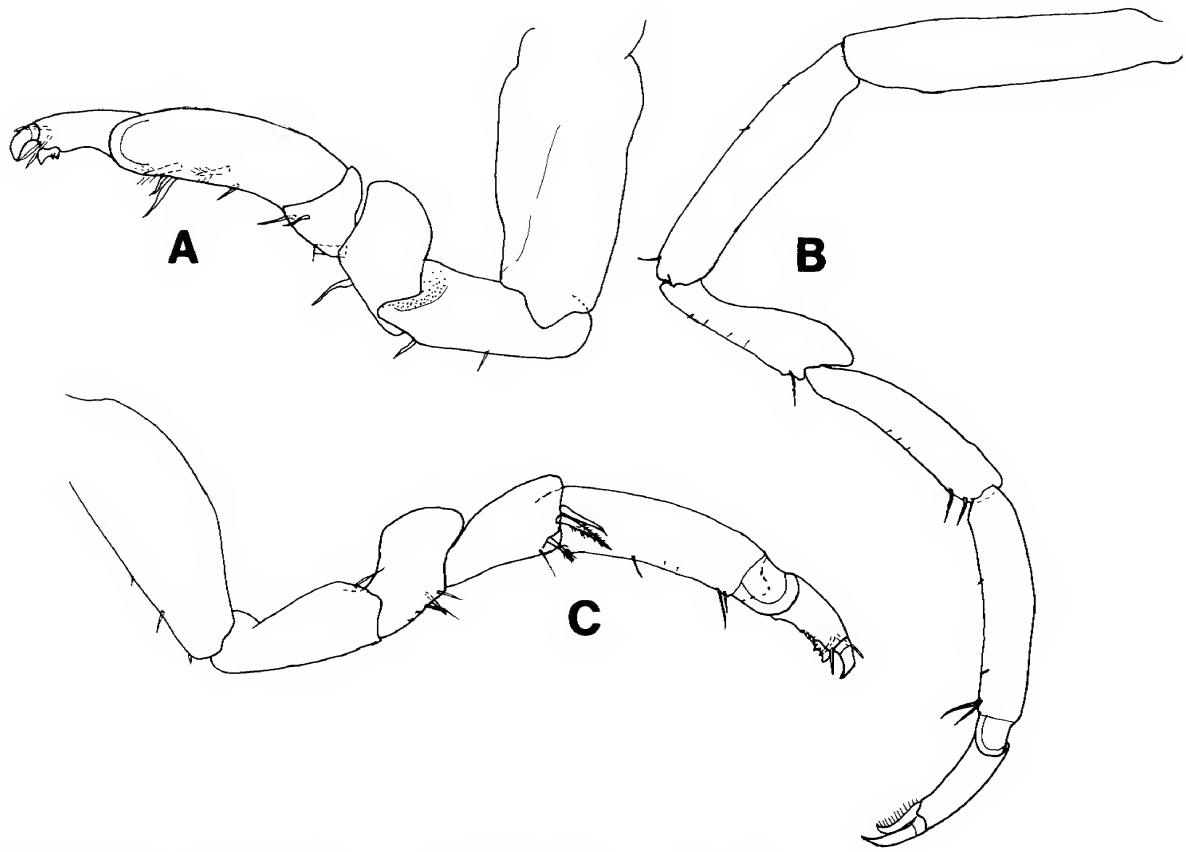

Figure 41. *Pedinura mokari* sp. nov. Male paratype NMV J39721. A–C, pereopods 1, 2 and 7.

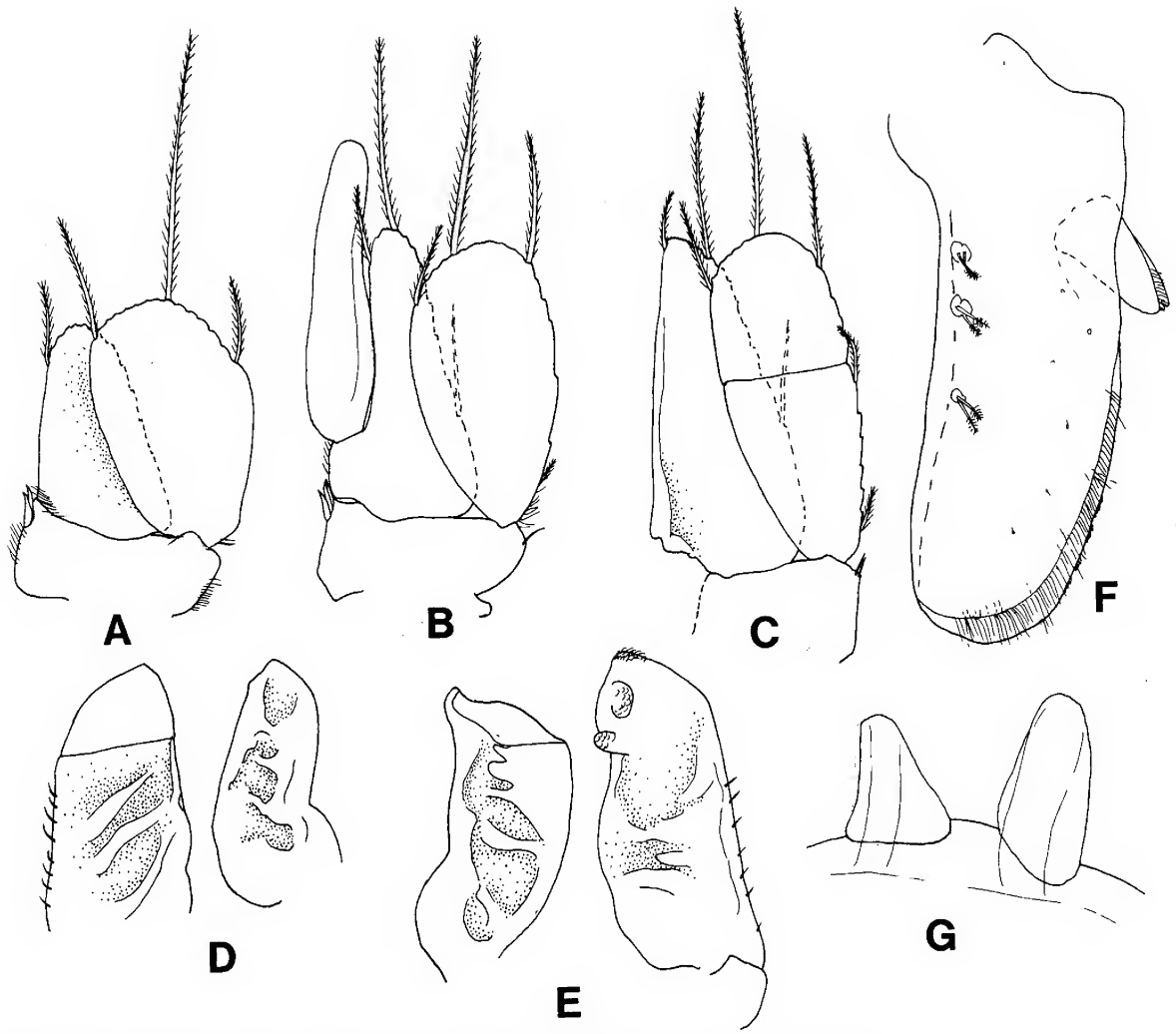

Figure 42. *Pedinura mokari* sp. nov. Male paratype NMV J39721. A–E, pleopods 1–5; F, uropod; G, penes.

mm), SW of Eagles Nest, Venus Bay, 38°40′S, 145°40′E, 5 Mar 1982, 8 m, rocky, R.S. Wilson and G. Barber (NMV J26226). 6 females (ovigerous 3.0–3.5 mm, non-ovigerous 3.1–3.2 mm), E side of Cape Paterson, 38°41′S, 145°36′E, 5 Mar 1982, 6 m, rocky, R.S. Wilson, G. Barber et al. (NMV J26334).

Description of male. Body about 3.0 times as long as greatest width, lateral margins subparallel, pereonites of subequal width; dorsal surfaces smooth, unornamented. Head anterior margin without transverse ridge, rostral process present. Head 1.5 times as long as pereonite 1, pereonites 1>2=3=4=5>6>7. Pleotelson lateral margins straight, converging towards posterior, posterior margin flat with median excavation.

Antennule peduncle article 1 1.3 times as long as proximal width, about 2.0 times as long as article 2; article 2 flattened, 0.9 times as long as wide; article 3 about 0.9 times as long as article 2; flagellum 5-articled, extending to anterior of pereonite 1, about as length of articles 2 and 3 combined. Antenna similar to type species, flagellum with 9 articles.

Epistome smooth, narrow, laterally encompassing labrum, widest anteriorly with distinct and convex anterior margin, lateral margins shallowly concave. Mandible incisor with 4 cusps; lacinia mobilis present; spine row of 4–5 serrate curved spines; molar process appearing large, with serrate margins or ridged surfaces; palp article 1 longest, without setae; article 2 without setae, article 3 with 7 biserrate setae, distal 2 setae being largest. Maxillule mesial lobe with 4 long and 2 shorter CP; lateral lobe with 10 peripheral simple RS on gnathal surface. Maxilla lateral lobe and middle lobe each with 4 curved, flat, finely serrate RS respectively, mesial lobe with about (not clearly observed) 8 RS, variously serrate. Maxilliped endite extending about half way along palp article 3, distal margin with 1 conical RS, 2 rounded RS, 1 cactus RS and 2–3

slender CP RS; palp articles 2–5 with about 5, 9, 10 and 9 setae respectively.

Pereopod 1 basis about 2.3 times as long as greatest width, about 1.4 times long as propodus, widest proximally; ischium 0.6 times as long as basis, 2.58 times as long as greatest width, inferior margin with 2 acute simple setae, one set at distal angle; merus about 0.4 times as long as ischium, 0.8 times as long as greatest width, inferior margin with 2 acute RS; carpus (inferior margin) 0.7 as long as merus, 0.7 times as long as wide, inferodistal angle with 2 simple setae; propodus 12 times as long as ischium, 32 times as long as greatest width, inferior margin with single proximal seta, inferomesial margin with 2 biserrate RS, inferodistal margin with 2 simple RS adjacent to base of dactylus; dactylus 0.5 times as long as propodus, unguis strongly recurved, inferior margin with few small cuticular scales, secondary unguis recurved with 2 basal cusps. Pereopod 2 with all articles slender; basis about 6.7 times as long as greatest width, about 1.3 times as long as propodus; ischium 0.8 times as long as basis, 4.7 times as long as greatest width, inferodistal angel with single seta; merus about 0.7 times as long as ischium, 3.1 times as long as greatest width, superior distal margin convex, inferodistal angle with single slender seta; carpus 1.1 as long as merus, 4.7 times as long as wide, inferodistal angle with 2 slender setae; propodus about as long as ischium, 5.7 times as long as greatest width; dactylus 0.6 times as long as propodus, unguis slender, apically falcate, secondary unguis flat and strongly pectinate, extending alongside unguI. Pereopod 3 similar to 2, but a little more robust. Pereopods 4–7 similar to pereopod 1, but more slender, carpus quadrate rather than subtriangular, propodus inferior margin without biserrate RS; all pereopods without trifid and biserrate setae. Pereopod 7 basis with proximal flange; carpus distal margin with 3 biserrate acute RS.

Penial processes separate, about 1.3–1.6 times as long as basal width, tapering distally to rounded apex.

Pleopod 1 exopod and endopod with c. 14 and 12 PMS respectively; rami of similar size, endopod 0.9 as long as exopod, 1.6 times as long as basal width, lateral margin converging slightly to rounded distal margin; exopod 1.5 times as long as greatest width, margins convex, distal margin broadly rounded. Pleopod 2 exopod and endopod with c. 20 and 11 PMS respectively, pleopod 2 endopod about as long as exopod, 2.0 times as long as greatest width, lateral margin strongly recessed at insertion point of appendix masculina; appendix masculina attached about one-quarter of way along mesial margin, about 4.4 times as long as wide, 1.1 times as long as endopod, apex bluntly rounded. Pleopod 3 exopod and endopod with c. 22 and 12 PMS respectively; both rami elongate, endopod very slightly (1.04) longer than exopod, 2.3 times as long as greatest width, proximal lateral margin convex. Pleopod 4 both rami with obscure ridges, exopod lateral margin with fine setae, exopod suture complete. Pleopod 5 both rami with indistinct ridges; exopod with 3 distal scale patches, transverse suture absent. Uropod rami flattened, margins provided with mebrana cingula; exopod inserted into lateral margin at about one-quarter from proximal margin, 02 times as long as fused endopod, triangular, apex subacute; endopod anterolateral margin weakly convex, posterolateral part rounded, mesial margin straight; mesially with 3 cluster of 2 sensory setae.

Female. Sexes similar, the dimorphism of the type species apparently not present in this species

Size. Males 3.1–3.2 mm, ovigerous females 3.0–3.5 mm, non-ovigerous females 3.1–3.2 mm.

Etymology. Mokari is an Aboriginal word meaning new; noun in apposition.

Distribution. Vic. and SA, where it is sympatric with the more widely distributed *P. flindersia*; 5–11 m, rocky habitats.

Remarks. Pedinura mokari is separated from the only congener, *P. flindersia* by the posteriorly indented pleotelson, the epistome being widest anteriorly and visible in dorsal view and the weakly expanded antennular peduncle articles 1 and 2.

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* Indicates that the reference has not been sighted.

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Appendix. Species currently placed in Exosphaeroma Stebbing, 1900

Many species of *Exosphaeroma*, including all those described by Keppel H. Barnard from southern Africa and all those described by W.H. Baker from southern Australia during the first half of the twentieth century (13 of the 32 included here), need redescription, but only those that are particularly inadequately described or are of uncertain generic status are mentioned as such. Australian species are shown in bold.

***Exosphaeroma agmokara* sp. nov.** Type locality—Broken Head, Northern NSW Australia; intertidal, under rocks on sand.

***Exosphaeroma aliae* Baker, 1926.** Type locality—Victor Harbour, South Australia.

***Exosphaeroma alveola* sp. nov.** Type locality—Jervis Bay, New South Wales, Australia; intertidal.

Exosphaeroma amplicauda (Stimpson, 1857). Type locality—Monterey Bay, California; in need of redescription [original combination *Sphaeroma*].

Exosphaeroma antikraussi Barnard, 1940. Type locality—Barnard cited several locations in South Africa.

***Exosphaeroma bicolor* Baker, 1926.** Type locality—Kangaroo Island, South Australia.

Exosphaeroma brevitelson Barnard, 1914. Type locality—Sea Point, near Cape Town, South Africa; intertidal.

Exosphaeroma bruscai Espinoza-Pérez and Hendrickx, 2001. Type locality—Los Arcos, Jalisco, Pacific Mexico; among inter-tidal algae and rocks to a depth of 3 metres.

Exosphaeroma diminutum Menzies and Frankenberg, 1966. Type locality—Sapelo Island, Georgia, USA; Chesapeake Bay to Florida and Venezuela (Kensley and Schotte 1989); this species does entirely conform to the genus.

Exosphaeroma echinensis Hurley and Jansen, 1977. Type locality—Kaikoura, New Zealand; intertidal and subtidal.

Exosphaeroma estuarium Barnard, 1951. Type locality—Umbagaga Estuary, near Umkomaas, Natal coast, South Africa; among *Zostera* seagrass.

Exosphaeroma falcatum Tattersall, 1921. Type locality—Spirits Bay, North Cape, New Zealand; subtidal to 20 m.

***Exosphaeroma gigas* (Leach, 1818). Type species.** Type locality—unknown ('*Son pays inconnu.*'); this species has a wide reported distribution in the Southern Hemisphere, including Macquarie Island and Tasmania, but from the time that the genus was established (Stebbing 1900; more recently Poore et al. 2002) there has been at least a subjective doubt that all material under this name is correctly identified [original combination *Sphaeroma*]

Exosphaeroma hylecoetes Barnard, 1940. Type locality—Barnard cites several locations in South Africa.

Exosphaeroma inornata Dow, 1958. Type locality—Palos Verdes, Los Angeles County, California, under kelp holdfasts.

Exosphaeroma kraussi Tattersall, 1913. Type locality—Saldanha Bay, Cape Town, South Africa; the uropodal exopod is clearly figured as serrate, and the species is in need of redescription.

***Exosphaeroma laevis* (Baker, 1910).** Type locality—Gulf of Saint Vincent, South Australia [original combination *Zuzara*].

Exosphaeroma laevisculum (Heller, 1868). Type locality—South Africa [original combination *Sphaeroma.*

Exosphaeroma media George and Stromberg, 1968. Type locality—San Juan Island, Washington, USA.

Exosphaeroma montis (Hurley and Jansen, 1978), *comb. nov.* Type locality—Mount Maunganui, New Zealand; intertidal; conforms well with the diagnosis for *Exosphaeroma* [original combination *Cymodopsis*] and is here transferred to that genus; see 'Remarks' for *Exosphaeroma alveola* sp. nov. for comments.

Exosphaeroma obtusum (Dana, 1853). Type locality—Bay of Islands, New Zealand; widely recorded around New Zealand; also Stewart Island, Auckland Island, the Snares Islands, Campbell Island and Chatham Island (Hurley and Jansen 1977); intertidal [original combination *Sphaeroma*].

Exosphaeroma octoncum (Richardson, 1899). Type locality—Monterey Bay, California [original combination *Sphaeroma*]; in need of redescription.

***Exosphaeroma pallidum* Barnard, 1940.** Type locality—Woodstock Beach, Table Bay, South Africa; also recorded from southern Australia.

Exosphaeroma parva Chilton, 1924. Type locality—Chilka Lake, India; in need of redescription.

Exosphaeroma planum Barnard, 1914. Type locality—Sea Point, near Cape Town, South Africa; intertidal.

Exosphaeroma planulum Hurley and Jansen, 1977. Type locality—Heathcote–Avon Estuary, Christchurch, New Zealand; intertidal, estuarine; a replacement name for homonym *Exosphaeroma planum* Hurley and Jansen, 1970.

Exosphaeroma porrectum Barnard, 1914. Type locality—South Africa; intertidal to 5 metres.

Exosphaeroma rhomburum (Richardson, 1899). Type locality—California [original combination *Sphaeroma*].

***Exosphaeroma serventii* Baker, 1928.** Type locality—Pallinup Estuary, on the Great Australia Bight coast of Western Australia.

Exosphaeroma studeri Vanhöffen, 1914. Type locality—Punta Arenas, Chile.

Exosphaeroma truncatitelson Barnard, 1940. Type locality—Kleinmond, Cape Province, South Africa.

Exosphaeroma varicolor Barnard, 1914. Type locality—Woodstock Beach and Sea Point, near Cape Town, South Africa.

Incertae sedis

Exosphaeroma alba Menzies and Glynn, 1968. Puerto Rico. This species and its named variety *E. alba chromata* Menzies and Glynn, 1968 were provisionally placed in *Exosphaeroma* (as ?*Exosphaeroma*) by Menzies and Glynn (1968). The morphology or the antennule peduncle, penial processes, shape and orientation of pleopod 1 rami, appendix masculina, and pleonal sutures (which run to the posterior margin of the pleon) and the pleotelson with a distal incision (or exit channel) all preclude its inclusion in *Exosphaeroma*, and suggest a closer affinity with *Dynamenella*. Remarkably, Menzies and Glynn (1968) considered the most similar species to be a species of *Dynamenella*, yet placed their new species in *Exosphaeroma*.

Exosphaeroma antillense Richardson, 1912. Type locality—Montego Bay, Jamaica (Kensely and Schotte, 1989); the bidomed pleotelson together with the short uropodal exopod and overlapping oostegites suggest that this is not a species of *Exosphaeroma* (as suggested by Kensley and Schotte 1989).

Exosphaeroma antarctica Richardson, 1908. Type locality—Port Madryn, Patagonia; the description and figures are of insufficient detail to distinguish this species from similar species such as *E. gigas* and *E. obtusum*.

Exosphaeroma aphrodita Boone, 1923. Type locality—La Jolla, California. This species has never been illustrated, and from the description given by Boone it is not possible to assess its status. Boone's description describes the dorsal surfaces of the body as being highly nodular and ornamented.

Exosphaeroma productatelson Menzies and Glynn, 1968. Puerto Rico. This species is very similar to *E. alba*, and the comments given for that species also apply entirely to this species, except the posterior margin of the pleotelson is entire.

Exosphaeroma yucatanum (Richardson, 1901). Included in *Exosphaeroma* by Kensley and Schotte (1989). The trilobate pleotelson and tri-domed pleotelson dorsum would indicate that this is not a species of *Exosphaeroma*.

Exosphaeroma coatsii Tattersall, 1913. Port Stanley, Falkland Islands. This species is based on females and has prominent nodules across the pereonites, pleon and pleotelson. The uropods have smooth margins, and the apex is of the pleotelson is acute. I am unaware that this species has been placed into synonymy, but as it is based on females there is the possibility that it is a species of *Isocladus*. Not included in Nierstrasz's (1931) listing of species.

Exclusions

Exosphaeroma crenulatum Richardson, 1902. Synonym of *Dynamenella perforata* (Moore, 1902) (see Glynn, 1974).

Exosphaeroma pulchellum Colosi, 1921. Synonym of *Sphaeroma hookeri* (Leach, 1818) (see Jacobs, 1987).

Exosphaeroma calcareum (Dana, 1853). At times placed in *Exosphaeroma* (e.g. Nierstrasz, 1931), more recently retained in *Isocladus* (e.g. Menzies, 1962).

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Neastacilla Tattersall, 1921 redefined, with eight new species from Australia (Crustacea: Isopoda: Arcturidae)

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Abstract

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The arcturid isopod genus *Neastacilla* is rediagnosed and eight new species from Australia (*Neastacilla coonabooloo* sp. nov., *Neastacilla kanowna* sp. nov., *Neastacilla lawadi* sp. nov., *Neastacilla marrimarri* sp. nov., *Neastacilla soelae* sp. nov., *Neastacilla tarni* sp. nov., *Neastacilla tharnardi* sp. nov. and *Neastacilla yuriel* sp. nov.) are described. Five species from Australia and New Zealand are rediagnosed. A key to differentiate Australian and New Zealand species is presented.

Keywords

Crustacea, Isopoda, Arcturidae, *Neastacilla*, taxonomy, Australia

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Introduction

The valviferan isopod family Arcturidae Dana, 1849 is represented in Australia by four genera. *Parastacilla* Hale, 1924 is an endemic Australian genus, its four species reviewed by King (2000). *Amesopous* Stebbing, 1905 is monotypic and its species, *A. richardsonae* Stebbing, 1905, was recorded from tropical Australia by Poore et al. (2002). *Astacilla* Cordiner, 1793 is represented by one species (King, 2003). The Australian fauna is dominated by species of *Neastacilla* Tattersall, 1921, here reviewed.

The systematics of *Neastacilla* has always been problematical. The genus was established by Tattersall (1921) for New Zealand specimens of '*Astacilla falclandica* Ohlin', a species originally described from the Falkland Islands. Tattersall's record was shown to be a misidentification and Tattersall's species is now *Neastacilla tattersalli* (Lew Ton and Poore, 1986a). Tattersall (1921) differentiated *Neastacilla* from *Astacilla* Cordiner, 1793 primarily on the absence of an anterolateral expansion of the head and pereonite 1 over the mouthparts (apparent in *Astacilla*) and by the completely fused pleon (as opposed to visible pleonite segmentation in *Astacilla*). These characters were later shown to be variable as more species were described (Nordenstam, 1933; Hale, 1946) and the newer genus did not become widely accepted.

Nordenstam (1933) was the first to rediagnose *Neastacilla*. Modifying Tattersall's diagnosis, Nordenstam argued that up to

three pleonite segments could be detected "indicated by shallow grooves," the first pereopod lacked an unguis, and the endopod of the uropod bore one seta. He also suggested (erroneously it turns out) that *Astacilla amblyura* Stebbing belonged in *Neastacilla*. Nordenstam acknowledged the lack of descriptive information concerning key *Neastacilla* characters and despite his diagnosis was not fully convinced of the validity of *Neastacilla*. He believed that *Neastacilla* would be made redundant when more detailed information was known or when species intermediate between *Astacilla* and *Neastacilla* were found.

Later, Hale (1946) documented arcturid species from Australia, New Zealand and the Southern Ocean. He described five new species, which he placed in *Astacilla*, and transferred his two previously described species of *Neastacilla* (*N. algensis, N. deducta*) to *Astacilla*. While acknowledging the morphological similarities of his new species to *Neastacilla*, as defined by Nordenstam (1933), Hale argued that *Neastacilla* was ambiguously defined; all his specimens possessed two uropodal endopod setae and so he placed them in *Astacilla*. Despite reservations, neither Hale (1946) nor Guiler (1949) who later described Tasmanian species, attempted to synonymise *Neastacilla*. Birstein (1963) was the first to argue that *Neastacilla* should be synonymised with *Astacilla* on the basis of its variable characters. Later, Monod (1970) synonymised *Neastacilla* with *Astacilla* in his partial revision of *Astacilla*.

Following extensive examination of material from the north-west Pacific, Kussakin (1972) re-established the genus, placing more importance on the morphology of the anterior pereopods. He defined *Neastacilla* as including those taxa possessing a dactylus and an unguis on pereopod 1 and possessing shortened dactyli, without ungui, on pereopods 2–4. This was compared to *Astacilla*, which he defined as including those species lacking a dactylus on pereopod 1 and lacking dactyli on pereopods 2–4. He subsequently re-assigned all Pacific Ocean species of *Astacilla* to *Neastacilla*.

Kussakin's views were supported by H. M. Lew Ton (unpublished B.Sc.(Hons) thesis, Monash University, 1980) who studied Australian species of *Neastacilla*. She concluded that the characters Kussakin used to separate the two genera were valid but should be modified slightly, as some Australian species of *Neastacilla* lack dactyli on pereopods 2–4 (some species with dactyli on pereopod 4 only and others without dactyli on pereopods 2–4). The loss of the dactyli on pereopods 2–4 occurs elsewhere in Arcturidae (in *Parastacilla*) and in another valviferan family, Chaetiliidae (in *Chaetilia* Dana) and is considered a synapomorphy for each genus. Lew Ton found biogeographical support for the distinction of *Astacilla* from *Neastacilla*. Most species of *Neastacilla* are found in the Pacific and those of *Astacilla* in the Atlantic Ocean, Mediterranean and Indian Ocean.

Without the evidence of Lew Ton's comprehensive unpublished work, other authors questioned Kussakin's (1972) conclusions. Schultz (1981) attempted to synonymise *Neastacilla*, placing all the known species into *Astacilla*, *Arcturus* Latreille or *Arcturella* Sars as he regarded the presence of an unguis on pereopod 1 as a variable character. Menzies and Kruczynski (1983) argued that the elongation of pereonite 4 was a more useful character than whether or not an unguis was present on pereopod 1 and also treated *Neastacilla* and *Astacilla* as synonyms.

While characters used in diagnosing the genus remain debatable, Kussakin's observations provide support for the recognition of *Neastacilla* as a genus. There have been no revisions of the genus in the past 20 years. As the type of *Astacilla falclandica* has been lost, Lew Ton and Poore (1986a) redescribed *N. falclandica* (Ohlin, 1901), proposing that it should be kept as the type species for the genus despite Tattersall's mistake (Lew Ton and Poore, 1986b; ICZN, 1987).

Whether or not *Neastacilla* is a monophyletic group is yet to be determined, but the genus remains valid. In this contribution a new diagnosis of *Neastacilla* is given, eight new Australian species are described, and five Australian and New Zealand species are rediagnosed. Poore et al. (2002) listed *Arcturus brevicornis* Haswell, 1881 as a possible Australian species of *Neastacilla* but in the absence of a good description, and of type material, the name cannot be applied to any known species. A key is provided for all species from these two countries.

Isopods came from collections in Australia of Museum Victoria, Melbourne (NMV), the South Australian Museum, Adelaide (SAM), the Australian Museum, Sydney (AM) and the Tasmanian Museum and Art Gallery, Hobart (TM). Material of some species was unavailable for study and short diagnoses derived from published literature are presented instead of full descriptions (see *Remarks* sections). Illustrations were made using microscopes with a camera lucida attachment. Australian Aboriginal names used as species epithets are to be treated as nouns in apposition. States and territories of Australia are abbreviated as follows: NSW (New South Wales), Vic. (Victoria), WA (Western Australia), SA (South Australia), Tas. (Tasmania), and NT (Northern Territory). Dimensions are total body length. In figures limbs are abbreviated: A1, antenna 1; A2, antenna 2; MX1, maxilla 1; MX2, maxilla 2; MD, mandible; MXP, maxilliped; P1–P5, pereopods 1–5; PL1–PL2, pleopods 1, 2; U, uropod or its rami; Pe, penial plate.

Arcturidae Dana, 1849

Neastacilla Tattersall, 1921

Neastacilla Tattersall, 1921a: 243–244.—Nordenstam, 1933: 118–119.—Kussakin, 1972: 178-189-.—Kensley, 1978: 31.—Wägele, 1991: 91.

Type species. Astacilla falclandica Ohlin, 1901, by plenary powers (ICZN, 1987).

Diagnosis. Body cylindrical, slender and strongly geniculate between pereonites 4 and 5. Pereonite 1 fused to head, fusion indicated by groove, occasionally by lateral incision. Pereonite 4 elongate, 3–10 times length of all other pereonites. Pleon about same length as combined lengths of pereonites 5–7. Antenna 2 slender, flagellum of 2 or 3 articles with claw. Pereopod 1 included within margin of head, dactylus as long as wide; carpus and propodus of subequal length; dactylus without unguis, with distal setae. Pereopods 2–4 slender; with long, closely spaced setae; dactylus reduced and claw-like [lost entirely in a few Australian species]; flexion between carpus and propodus absent. Pereopods 5–7 progressively shorter posteriorly, dactylus with unguis and secondary unguis. Oostegites present on pereopods 1–4; oostegite 4 forming the major part of

marsupium, thickened. Male pleopod 1 with lateral notch and setae on posterior face. Male pleopod 2 appendix masculina curved, with a ridge on posterior face, not extending much past endopod. Penial plate simple, tapering to apex, straight.

Composition. 38 species, excluding those *inquirenda* (see Table 1).

Remarks. Characters such as the morphology of pleopods 1 and 2 (including the short, curved appendix masculina), simple fused penial plate and the morphology of oostegite 4 in females are new characters used here to redefine *Neastacilla*. Importance has also been placed on the absence of flexion between the carpus and propodus in pereopods 2–4 (apparent in *Astacilla*). Many existing description do not include these characters and so some species (especially those from the North-west Pacific) remain uncertainly placed within *Neastacilla*.

According to Kussakin's criteria *N. tzvetkowae* belongs to *Astacilla* or possibly *Arcturus* because it possesses an antenna 2 with 3 or more flagellar articles and probably has an unguis

Table 1. Distributional information for *Neastacilla* species

Species of *Neastacilla*	Distribution	Depth range
N. algensis Hale,1924	Australia, SA	11–12 m
N. antipodea Poore, 1981	Subantarctic New Zealand	intertidal to 15
N. attenuata (Hale, 1946)	Australia, NSW	60–83 m
N. bacillus (Barnard, 1920)	South Africa	5–400 m
N. californica (Boone, 1918)	California, USA	18–100 m
N. coonabooloo sp. nov.	south-eastern Australia (NSW, Vic., Tas.)	subtidal to 9 m
N. deducta Hale, 1924 (synonym: *Astacilla vicaria* Hale, 1946)	south-eastern Australia (NSW, Vic., Tas., SA)	9 m
N. diomedeae (Benedict, 1898)	Straits of Magellan	subtidal to 34 m
N. estadoensis (Schultz, 1981)	Argentina	intertidal
N. exilis Kussakin, 1971	North-west Pacific	400 m
N. falclandica (Ohlin, 1901)	Falkland Islands	subtidal
N. fusiformis (Hale, 1946)	New Zealand, Hauraki Gulf	? (tow net)
N. inaequispinosa (Guiler, 1949) (synonyms: *Astacilla derwenti* Guiler, 1949; *A. oculata* Guiler, 1949; *A. unicornis* Guiler, 1949)	south-eastern Australia, Vic., Tas.	18 m
N. kanowna sp. nov.	South-eastern Australia, Vic., Tas., SA	subtidal to 29 m
N. kurilensis Kussakin, 1974	Kurile Islands	intertidal to 60 m
N. lawadi sp. nov.	Australia, Vic., Tas., SA, WA, NT	subtidal to 82 m
N. leucophthalma Kussakin, 1971	North-west Pacific	400 m
N. levis (Thomson and Anderton, 1921)	New Zealand, Cook Strait	31 m
N. littoralis Kussakin, 1974	Kurile Islands	0–45 m
N. macilenta (Hale, 1946)	Australia, NSW	2.5 m
N. magellanica (Ohlin, 1901)	Straits of Magellan	12–208 m
N. marionensis (Beddard, 1886) (synonym: *Astacilla kerguelenensis* Vanhöffen, 1914)	Marion Islands, Kerguelen Islands	45 to 340 m
N. marrimarri sp. nov.	Australia, WA	subtidal to 25 m
N. monoseta (Guiler, 1949)	South-eastern Australia, Vic., Tas.	subtidal to 84 m
N. nodulosa Kussakin, 1982	North-west Pacific	460 m
N. ochroleuca Kussakin and Vasina, 1990	Kurile Islands	880 m
N. pallidocula Kussakin and Vasina, 1990	Kurile Islands	910–920 m
N. polita (Gurjanova, 1936)	Sea of Japan	25–60 m
N. richardsonae Kussakin, 1982 (replacement name for *Astacilla dilatata* Richardson, 1909)	North-west Pacific	128 m
N. sheardi (Hale, 1946)	South-eastern Australia, NSW, Vic., SA	subtidal
N. soelae sp. nov.	Australia, WA	subtidal to 52 m
N. tarni sp. nov.	Australia, SA	subtidal to 15 m
N. tattersalli Lew Ton and Poore, 1986a	New Zealand	20–129 m
N. tharnardi sp. nov.	south-eastern Australia, Vic., SA	subtidal to 20 m
N. tristanica Sivertsen and Holthuis, 1980	South Atlantic, Nightingale Island	intertidal to 10 m
N. tuberculata (Thomson, 1879)	New Zealand	8–10 m
N. yuriel sp. nov.	New Zealand	subtidal to 201 m
N. vitjazi Kussakin, 1971	North-west Pacific	820–1050 m
Species inquirenda		
Neastacilla sirenkoi Kussakin and Vasina, 1990	Kurile Islands	880 m
Neastacilla tritaeniata Kussakin, 1982	Bering Sea	5–77 m
Neastacilla tzvetkowae Kussakin, 1974	Kurile Islands	0–43 m

on pereopod 1. *N. tritaeniata* was not thoroughly described but the flagellum of antenna 2 is composed of five articles and pereonite 4 is not elongate, suggesting a species of *Arcturus*. Similarly, *N. sirenkoi* has four antenna 2 flagellar articles and an unguis on the dactylus of pereopod 1 and should be placed in *Arcturus*. Further, these three species are all from the North-west Pacific where other species of *Arcturus* occur.

It is possible that *Astacilla cymodocea* Menzies and Glynn, 1968 from the Caribbean may yet be included in *Neastacilla* as it is described as lacking an unguis on pereopod 1 and lacking dactyli on pereopods 2–4. With no information available on the male sexual appendages (no specimens could be examined), it is not included here.

The morphology of arcturid oostegites is considered here to be taxonomically important, yet these characters have not often been included in species descriptions or illustrations. The morphology of oostegite 4, for example, was discovered to vary within *Neastacilla*. In some species of *Neastacilla* (*N. coonabooloo, N. deducta, N. monoseta* and *N. soelae*) there is a midlength suture in oostegite 4 that is not found in any other genus (Figs 3A, 4E, 18C, 20B). This suture is thought to be homologous to that separating the posterior lobe found on oostegite 4 in other species of *Neastacilla* (Fig. 7C, 9E, 14E) and in other genera. This condition is found in females where the pereonite 4 is extremely narrow and elongate. The smaller sutured posterior lobe may help aerate the marsupium while the female is brooding and it is possible that the suture found in elongate females performs a similar function.

Sexual characters are also argued here to be taxonomically important. Male pleopodal structure and female oostegites of the Australian and New Zealand species of *Neastacilla* differ from those in *N. richardsonae*, a north-western Pacific species. While it is the only species examined from this region, others from the north-western Pacific are figured similarly. *Neastacilla richardsonae* possesses a straight appendix masculina and a developed functional oostegite on pereopod 5. Both these character states are shared with *Arcturus* and not with Australian and New Zealand *Neastacilla* species. No information is available on the structure of the appendix masculina in other North-western Pacific species but the curved, ridged appendix masculina has so far only been found in Australian and New Zealand species of *Neastacilla* (and in *Parastacilla*, endemic to Australia (King, 2000)). The North-western Pacific species remain in *Neastacilla* for the time being but they may belong to *Arcturus*, a new genus, or both.

Biogeographical evidence supports the view that the north-western Pacific species may belong to another genus. The majority of the species from around Australia and New Zealand are found in the Pacific Ocean, with four of the new Australian species described here (*Neastacilla lawadi, N. marrimarri, N. soelae* and *N. yuriel*) reported from the Indian Ocean (coast of Western Australia). The centre of diversity of *Neastacilla* is evidently Australia and New Zealand with undisputed species also reported from subantarctic islands. Clearly, the north-west Pacific species are geographically separated from this radiation and thus are only conditionally included within the genus until further work can make clear their position. Species from southern South America, South Africa and California, USA were unavailable for study and are similarly included in the genus until further clarification.

Key to Australian and New Zealand species of *Neastacilla*

* Species known only from this sex.

1. Head with distinct dorsal tuberculation(s) or elevations(s) 2
— Head dorsally smooth or with small rounded elevation 14
2. Fusion of head and pereonite 1 indicated by a suture . . 3
— Fusion of head and pereonite 1 without a suture 4
3. Anterolateral margin of pereonite 1 extended laterally, head and pereonites 1–4 with large prominent branch–like elevations, pereopods 2–4 flattened *Neastacilla tharnardi*
— Anterolateral margin of pereonite 1 not extended laterally, head and pereonites 1–4 with very small anteriorly produced elevations, pereopods 2–4 cylindrical (male extremely elongate and elevations reduced to blunt tubercles) . . . . . *Neastacilla attenuata*
4. Pereonite 4 with large, prominent dorsal elevation(s) . . 5
— Pereonite 4 smooth or with small dorsal elevation(s) . . 7
5. Pleotelson equal to or longer than pereonites 5–7; pereonite 4 with proximal dorsal elevations (female pereonite 4 widened at midlength) 6
— Pleotelson shorter than pereonites 5–7; pereonite 4 with dorsal elevations at midlength (female pereonite 4 not laterally widened at midlength) . . . . . *Neastacilla marrimarri* (female)*
6. Pereonite 4 with large proximal dorsal elevation with 3 apices and 2 large lateral elevations; pleotelson with 2 pairs of lateral wings and widening distally to taper to a pointed apex (male pereonite 4 with single dorsal elevation proximally) . . . . . *Neastacilla tuberculata*
— Pereonite 4 with large dorsal midlength elevation with 2 apices with 2 large lateral elevations; pleotelson with 1 pair of lateral wings, not widened and sharply tapered to a bluntly rounded apex . . . . . *Neastacilla tarni* (female)
7. Pereonite 4 constricted (in dorsal view) for first third length 8
— Pereonite 4 not constricted (in dorsal view) for first third length 10
8. Pereonite 4 extremely elongate (10 times as long as pereonite 3 length) . . *Neastacilla inaequispinosa* (male)
— Pereonite 4 not extremely elongate (less than 10 times pereonite 3 length) 9
9. Pereonite 4 with dorsal and lateral elevations at midlength; pereonites 5–7 with a pair of dorsal elevations plus lateral elevations; pleotelson wider than pereonite 7, with 2 pairs of acute lateral wings . . . .*Neastacilla fusiformis* (male)*
— Pereonite 4 with a pair of small anterodorsal round tubercles; pereonites 5–7 smooth; pleotelson not wider than pereonite 7, with pair of blunt lateral wings . . . . . .*Neastacilla tarni* (male)
10. Head and pereonite 4 each with a pair of distinct spine–like elevations (male with elevations reduced to blunt tubercles) . . . . . *Neastacilla lawadi*
— Head and pereonite 4 smooth or with weak/ blunt elevations 11

11. Pereonite 4 without elevations; pleotelson longer than pereonites 5–7 12
— Peronite 4 with dorsal elevations; pleotelson not longer than pereonites 5–7 13
12. Pleotelson apex acute; antenna 2 peduncular article 5 as long as article 4 ..... *Neastacilla soelae* (female)*
— Pleotelson apex truncate; antenna 2 peduncular article 5 slightly shorter than article 4 ..... *Neastacilla algensis* (female)*
13. Pereonite 4 with dorsal rounded tubercles extending laterally at midlength; pleotelson as long as pereonites 5–7, with 2 distinct blunt lateral wings ..... *Neastacilla sheardi* (female)*
— Pereonite 4 with a weak dorsal elevation at midlength; pleotelson longer than pereonites 5–7, without defined lateral wings ..... *Neastacilla inaequispinosa* (female)
14. Fusion of head and pereonite 1 defined with a suture 15
— Fusion of head and pereonite 1 not defined with a suture 19
15. Eye large and triangular shaped; pleotelson with an apical blunt notch ..... *Neastacilla levis*
— Eye small, round or oval in shape; pleotelson without apical blunt notch 16
16. Pleotelson with large, acute lateral wings with an acute apex ..... *Neastacilla monoseta*
— Pleotelson without defined lateral wings, apex blunt 17
17. Pereonite 4 not more than 6 times as long as pereonite 3, almost square in dorsal view (male without strong tuberculation and pereonite 4 not square in dorsal view) ..... *Neastacilla antipodea*
— Pereonite 4 extremely elongate (greater than 8 times as long as pereonite 3), not square in dorsal view 18
18. Pereonite 4 with a pair of distinct dorsal elevations proximally (female with pereonite 4 laterally expanded and upturned at midlength, male pereonite 4 narrow and constricted (in dorsal view) for first third length ..... *Neastacilla coonabooloo*
— Pereonite 4 dorsally smooth (female with slight lateral expansion of pereonite 4 at midlength) ..... *Neastacilla deducta*
19. Adult size 3–4 mm; pereonite 4 with a dorsal elevation at midlength (males with pereonite 4 constricted (in dorsal view) proximally but with dorsal elevation at first third length) ..... *Neastacilla yuriel*
— Adult size >7 mm; pereonite 4 without dorsal elevations 20
20. Head with horizontal unsutured groove below eye; pleotelson with defined lateral wings (female pereonite 4 with anterolateral extensions) ..... *Neastacilla macilenta*
— Head without horizontal unsutured grove; pleotelson without defined lateral wings 21
21. Pereonite 4 elongate (greater than 8 times as long as pereonite 3); pleotelson with a truncated apex ..... *Neastacilla kanowna*
— Pereonite 4 around 6 times as long as pereonite 3; pleotelson bluntly rounded ..... *Neastacilla tattersalli* (female)*

Neastacilla algensis Hale

Neastacilla algensis Hale, 1924: 213, fig. 3.—Hale, 1929: 313, fig. 314.—Poore et al., 2002: 258.

Astacilla algensis.—Hale, 1946: 174, fig. 7A.—Monod, 1970: 1139.

Diagnosis of female. Eyes small and triangular. Head with rounded dorsal elevation slightly posterior to eyes; lateral margin of head and pereonite 1 not incised. Pereonites 1–7 dorsally smooth, without distinct lateral extensions. Pereonite 4 extremely elongate (more than 10 times as long as pereonite 3). Pleon longer than pereonites 5–7 combined, lateral wings absent, apex truncate. 12.3 mm.

Male. Undescribed.

Distribution. Australia: South Australia; subtidal.

Remarks. Neastacilla algensis is diagnosed here with reference to the illustrations of Hale (1924, 1929), who described a single female specimen. The elongate, truncated pleotelson and extremely elongate pereonite 4 separates this species from all others in *Neastacilla*. It should be noted that the specimen drawn by Hale (1924, 1929) was probably an immature female as he described the oostegites as not fully developed.

Neastacilla antipodea Poore

Neastacilla antipodea Poore, 1981: 333, figs 2–3.

Material examined. New Zealand: NMV J679 (1 male, 1 female).

Description of female. Head without dorsal elevation, anterolateral lobes rounded, rostral point absent; lateral margin of head and pereonite 1 incised. Pereonite 1 without lateral extension, with dorsal elevation. Pereonites 2 and 3 progressively wider; with distinct keel-like dorsal elevations, bilobed lateral extensions visible on dorsal view. Pereonite 4 about 5 times as long as pereonite 3, with single keel-like anterior dorsal elevation, anterolateral and posterolateral margins extended, forming a square shape in dorsal view. Peronites 5–7 progressively shorter posteriorly; without dorsal elevations. Pleon length subequal to the combined lengths of pereonites 5–7, without dorsal elevations, without lateral wings, apex bluntly rounded.

Eyes small and oval. Antenna 1 reaching to second peduncular article of antenna 2; aesthetascs present distally on flagellum. Antenna 2 robust, more than half as long as body; flagellum of 3 articles, ending with claw, row of scales along full length.

Maxilla 1 mesial lobe with 3 plumose terminal setae; lateral lobe with 11 distal robust setae. Maxilla 2 mesial lobe with about 20 plumose setae; middle lobe with 6 setae; lateral lobe with 3 setae. Maxillipedal endite with numerous mesial setae, 2 coupling hooks; palp article 2 with mesial setal rows; articles 3 and 4 with mesial and lateral setal rows; article 5 with mesial and distal setae.

Pereopod 1 propodus slightly shorter than carpus; dactlyus as long as wide, without unguis. Pereopods 2–4 with dactylus. Pereopods 5–7 dactylus denticulate, with unguis and secondary unguis; secondary unguis three-quarters length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 with sutured small posterior lobe.

Adult: 7.0–8.0 mm, juveniles 3.0–7.0 mm, mancas 2.0–3.0 mm

Male. Pereonite 1 without lateral extensions, without dorsal elevation. Pereonites 2 and 3 progressively wider; without distinct dorsal elevations, without lateral extensions. Pereonite 4 about 5 times as long as pereonite 3, without dorsal elevation, anterolateral and posterolateral margins not extended. Peronites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon length subequal to the combined lengths of pereonites 5–7, without dorsal elevations, without lateral wings, apex bluntly rounded.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae. Pleopod 2 appendix masculina with ridge on posterior face, curved, extending twice as long as the endopod, apex simple. Penial plate widened proximally, distally bulbous, apex acute.

Adult: 7.3–8.5 mm, juveniles 3.0–7.0 mm, mancas 2.0–3.0 mm.

Distribution. New Zealand: The Snares; intertidal to 15 m depth.

Remarks. Neastacilla antipodea is one of five species of *Neastacilla* (*N. fusiformis, N. tuberculata, N. levis, N. tattersalli*) known from New Zealand. The ornamentation of *N. antipodea* distinguishes it from all the other species immediately: specifically, the bluntly rounded pleon and the square shape of pereonite 4 of the female in dorsal view.

Neastacilla attenuata (Hale)

Astacilla attenuata Hale, 1946: 177–179, figs 9–10.—Monod, 1970: 1137–1139, figs 45–55.—Poore et al., 2002: 258.

Diagnosis of female. Eyes small and oval. Head with dorsal pair of small anteriorly directed spine-like elevations slightly posterior to eyes; lateral margin of head and pereonite 1 incised. Pereonites 2 and 3 with single dorsal, anteriorly directed spine-like elevations. Pereonite 4 extremely elongate (more than 10 times as long as pereonite 3); anterolateral margins expanded, with pair of small blunt anterodorsal elevations. Pleon longer than pereonites 5–7 combined, 2 pairs of small lateral wings present, apex acute. 7.5 mm.

Male. Similar to female except dorsal spines are reduced to blunt elevations on head and pereonites. 9.8 mm.

Distribution. Australia: New South Wales; 60–80 m.

Remarks. This species is diagnosed from the description of Hale (1946). This species is distinguished from other species by the presence of anteriorly directed spine-like dorsal elevations in the female, the elongate pereonite 4 (extremely elongate in males), and long pleon.

Neastacilla coonabooloo sp. nov.

Figures 1–3

Material examined. Holotype. Australia: Vic., Crib Point, Western Port, 38°21.15'S, 145°13.36'E, 9 m, 24 Mar 1965, NMV J1036 (1 female, 6.6 mm).

Paratypes. Australia: **NSW**. Moes Rock, S of Jervis Bay, AM P32681 (1 female), AM P32680 (1 female). **Vic.** Crib Point, Western Port, 38°21.63'S, 145°15.08'E, 9 m, 23 Feb 1965, NMV J978 (1 female), NMV J979 (1 female). Western Port, 38°22.0'S, 145°32.0'E, NMV J980 (1 immature female, 1 immature male). Mallacoota, 37°34.03'S, 149°46.02'E, 5 m, 6 Apr 1989, NMV J47324 (1 immature female). **Tas.** Breaksea Island, Bathurst Harbour, 4 m, 16 Feb 1989, NMV J47323 (1 male, 5.5 mm).

Description of female. Head with small dorsal elevation posteriorly, anterolateral lobes angular, small rostral point present; lateral margin of head and pereonite 1 incised. Pereonite 1 extended anterolaterally. Pereonites 2 and 3 without dorsal elevations, progressively wider, with small lateral extensions. Pereonite 4 about 8 times as long as pereonite 3, wider than previous pereonites, widest at midlength; with 2 anterior horn-like dorsal elevations, lateral margins extended and curved dorsally at midlength. Pereonites 5–7 progressively shorter posteriorly; without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7, without dorsal elevations, with small anterior lateral wings, apex rounded.

Eyes small and oval. Antenna 1 reaching to third peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 2 articles ending with claw, row of scales along full length.

Maxilla 1 mesial lobe with 3 plumose terminal setae; lateral lobe with 9 distal robust setae. Maxilla 2 mesial lobe with 22 plumose setae; middle lobe with 3 setae; lateral lobe with 3 setae. Maxillipedal endite with 13 mesial setae, 1 coupling hook; palp article 2 with mesial setal rows; articles 3 and 4 with mesial and lateral setal rows; article 5 with mesial and distal setae.

Pereopod 1 propodus as long as carpus; dactylus twice as long as wide, without unguis. Pereopods 2–3 dactylus present. Pereopod 4 dactylus absent. Pereopods 5–7 dactylus somewhat denticulate, with unguis and secondary unguis; secondary unguis half-length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 with suture at midlength.

5.0–6.6 mm.

Male. Head with a small dorsal elevation posteriorly, anterolateral lobes angular, small rostral point present; lateral margin of head and pereonite 1 incised. Pereonite 1 extended anterolaterally. Pereonites 2 and 3 of similar width; without dorsal elevations, small lateral extensions present. Pereonite 4 about nine times as long as pereonite 3, constricted for first third of length; with 2 anterior horn-like dorsal elevations, anterolateral margins not extended. Pereonites 5–7 progressively shorter posteriorly; without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7; without dorsal elevations, with small anterior lateral wings, apex rounded.

Antenna 1 reaching half way along third peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles ending with a claw, a row of scales full length.

Mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with a lateral notch and 2 plumose lateral setae of unequal length. Pleopod 2 appendix masculina

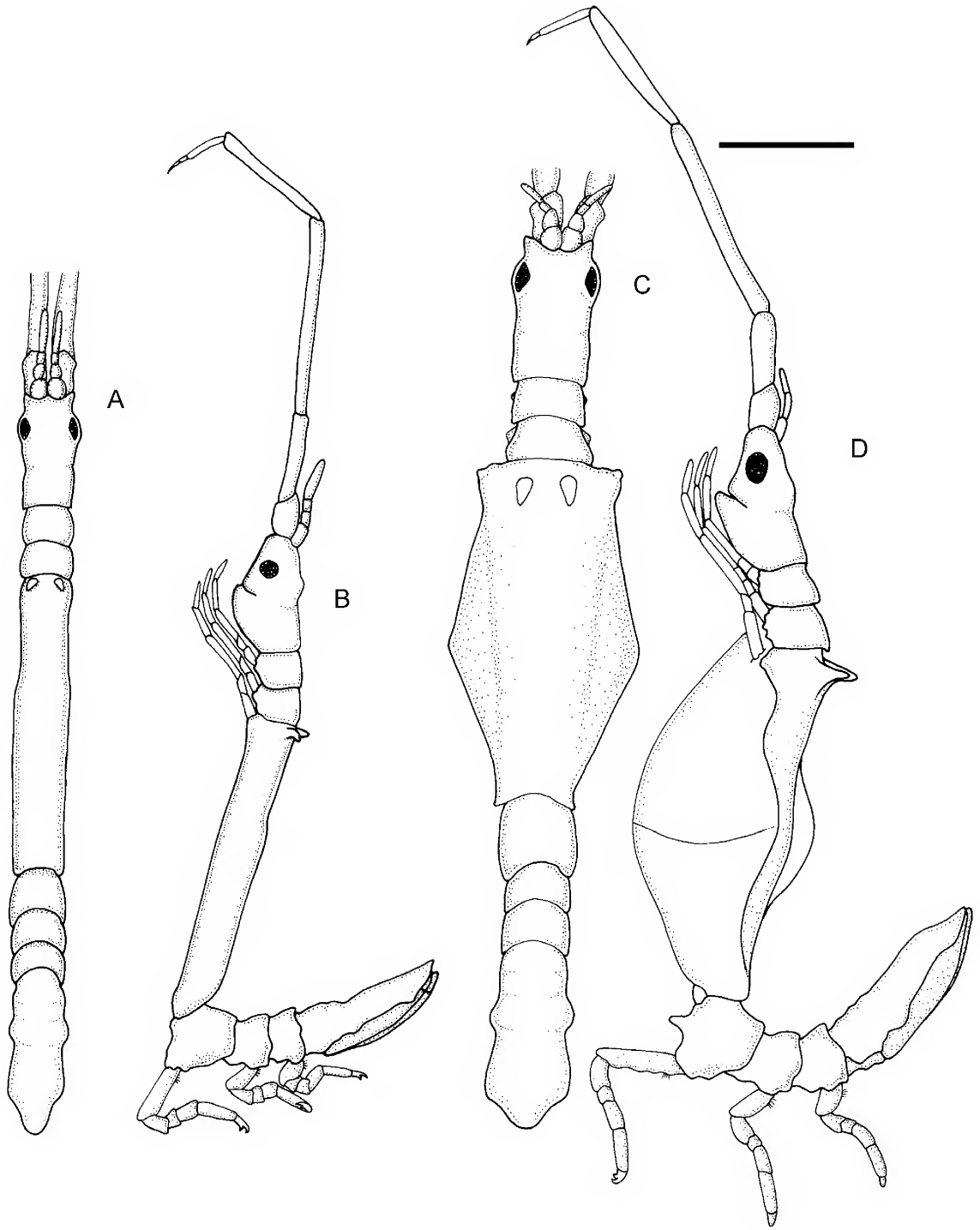

Figure 1. *Neastacilla coonabooloo* sp. nov., male (NMV J47323): A, dorsal view; B, lateral view. Female holotype (NMV J1036): C, dorsal view; D, lateral view. Scale = 1.0 mm.

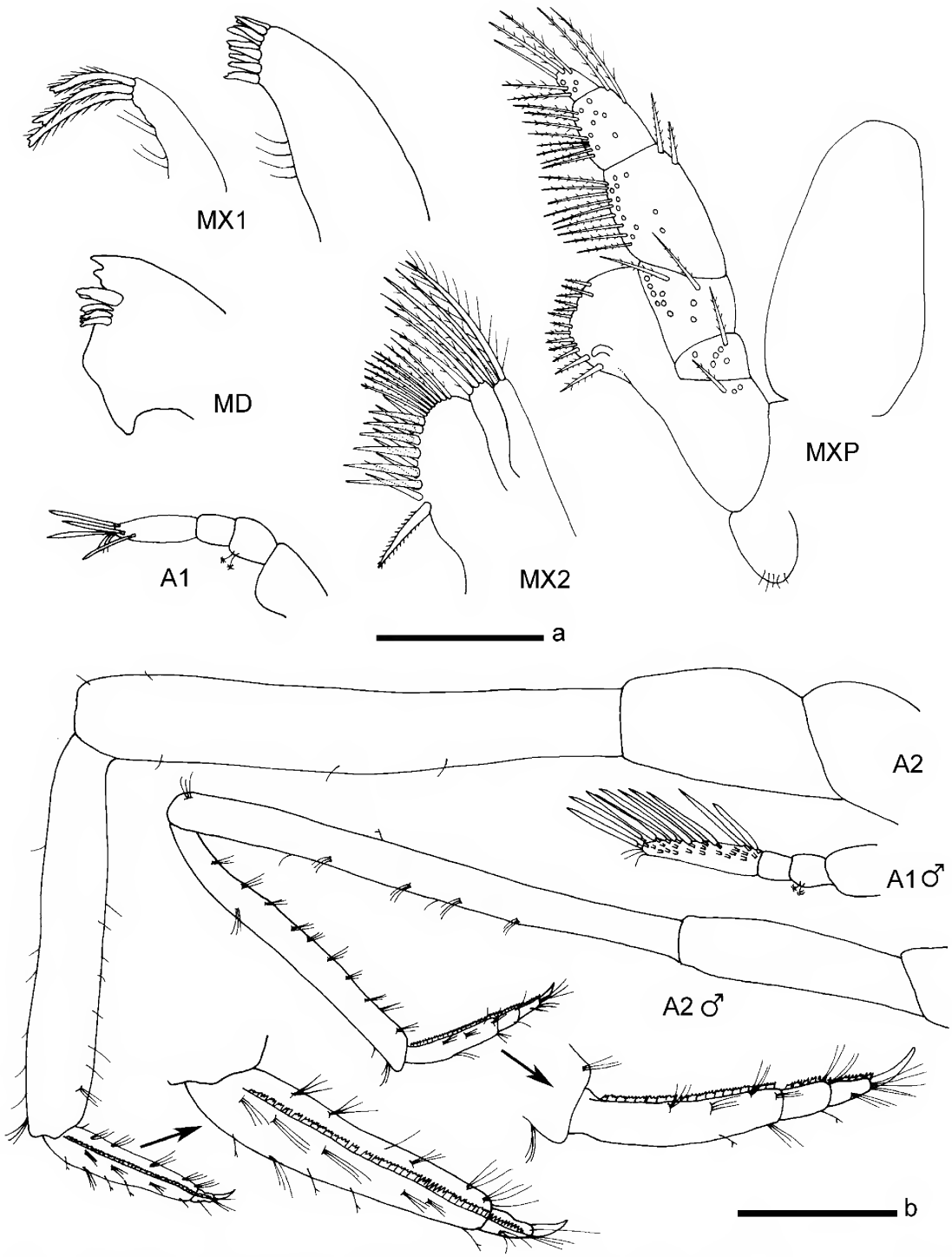

Figure 2. *Neastacilla coonabooloo* sp. nov., female holotype (NMV J1036): MX1, left MX2, left MD, left MXP, A1, A2, antenna 2. Male (NMV J47323): A1♂, A2♂. Scales: a (MXP, MX1, MX2, MD) = 0.2 mm; b (A1, A2) = 0.5 mm.

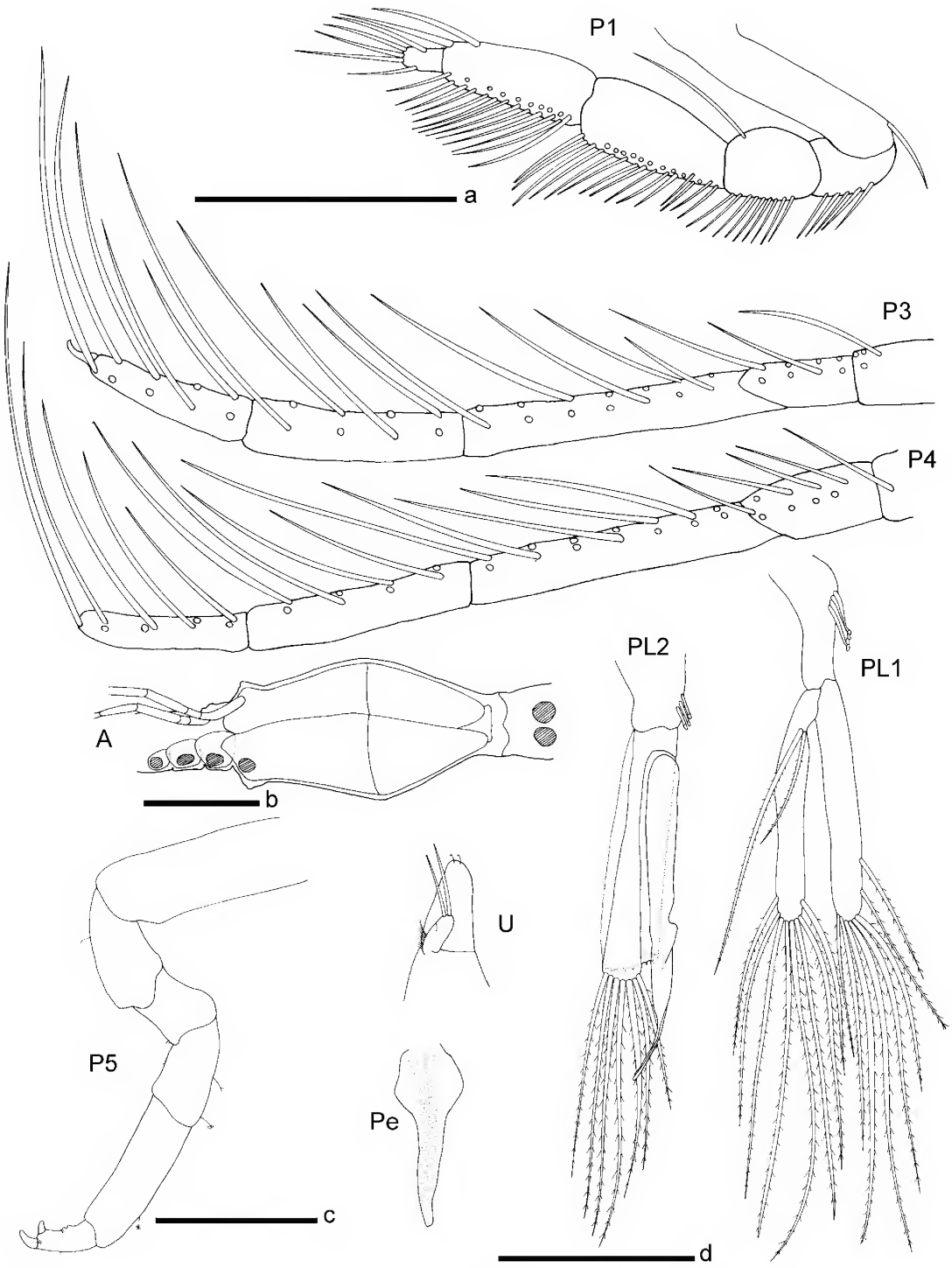

Figure 3. *Neastacilla coonabooloo* sp. nov., female holotype (NMV J1036): P1, P3, P4, P5, U; A, ventral view. Male (NMV J47323): Pe, PL1, PL2. Scales: a (P1, P3, P4) = 0.5 mm; b = (A) 1.0 mm; c (P5) = 0.5 mm; d (U, Pe, PL1, PL2) = 0.2 mm

with ridge on posterior face, curved, extending third length past the endopod, apex simple. Penial plate widened proximally, distally tapered, apex simple.

4.5–5.6 mm

Distribution. Australia: New South Wales, Victoria, Tasmania; subtidal to 9 m depth.

Etymology. "Coonabooloo" is an Aboriginal word meaning two shoulders and refers to the extended lateral margins of pereonite 4 in the female of this species.

Remarks. This species possesses an incised dorsolateral groove at the fusion of the head and pereonite 1 as does *Neastacilla deducta* and *N. monoseta*. Females of *N. coonabooloo* are distinguished from these two species by the presence of extended lateral margins on pereonite 4 and two anterior horn-like elevations on pereonite 4. Males of *N. coonabooloo* possess smaller horn-like elevations. *N. coonabooloo* can be further differentiated from *N. monoseta* by possessing a pleon with small rounded lateral wings, as opposed to the large acute wings in *N. monoseta.* In the material examined here, the heights of the dorsal elevations on pereonite 4 vary from small bumps to spine like elevations.

Neastacilla deducta Hale

Figures 4–6

Neastacilla deducta Hale, 1925: 33, fig. 16.—Hale, 1929: 313, fig. 315.—Monod, 1970: 1139.—Poore et al., 2002: 259.

Astacilla deducta.—Hale, 1946: 174–175, fig. 7.

Astacilla vicaria Hale, 1946: 175–176, fig. 8.—Monod, 1970: 1139.

Material examined. Holotype. Australia: SA, Port Adelaide (Gulf St Vincent) (1 male) SAM C 273. Paratypes. Australia: SA, Port Adelaide (Gulf St Vincent) SAM C 274.

Syntypes of *Astacilla vicaria* Hale, 1946. NSW, off Yarra Bay, Botany Bay, AM P8967 (8 specimens).

Other material. Australia: **NSW.** Jervis Bay, 35°08.0'S, 150°43.0'E, 2 m, 23 Apr 1985, NMV J11199 (2 females, 4 males, 1 immature female). Port Kembla, 34°29.0'S, 150°55.0'E, Mar 1978, NMV J16516 (1 female). **Vic.** Oberon Bay, 39°04.2'S, 146°19.4'E, 21 m, 05 Feb 1982, NMV J11200 (11 females, 7 males, 5 immature males, 2 manca 2). **Tas.** 43°17.0'S, 147°15.'E, 3 m, 20 Mar 1988, NMV J48664 (1 female); 39°32.8'S, 144°16.0'E, 18 m, 1 Nov 1980, NMV J8840. **SA.** Venus Bay, 33°13.2'S, 134°40.1'E, 2 m, 23 Apr 1985, NMV J40673 (1 female, 11.5 mm), NMV J 40674 (1 male, 11.3 mm), NMV J16569 (12 individuals); Venus Bay, 33°13.8'S, 134°40.1'E, 3 m, 21 Apr 1985, NMV J16570 (2 females, 1 male, 2 immature females, 1 immature male, 3 juveniles, 2 manca-2). NE side of Topgallant I., 33°43.0'S, 134°36.6'E, 20 m, 21 Apr 1985, NMV J16568 (3 females).

Description of female. Head without dorsal elevation, anterolateral lobes angular, small rostral point present; lateral margin of head and pereonite 1 incised. Pereonite 1 with an anterolateral expansion. Pereonites 2 and 3 similar width, without dorsal elevations, without lateral extensions. Pereonite 4 about 10 times as long as pereonite 3, with some small anterior dorsal elevations, anterior anterolateral margins extended, not greatly wider then previous pereonites. Pereonites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7, without dorsal elevations, with small anterior lateral wings, apex blunt.

Eyes small and subtriangular. Antenna 1 reaching to the end of second peduncular article of antenna 2; aesthetascs present laterally and distally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 2 articles, ending with claw, with row of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 9 distal robust setae. Maxilla 2 mesial lobe with 26 plumose setae, middle lobe with 3 setae, lateral lobe with 3 setae. Maxillipedal endite with 11 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, article 3 with mesial and lateral setal rows, article 4 with mesial setae, article 5 with distal setae.

Pereopod 1 propodus as long as carpus; dactylus slightly longer than wide, without unguis. Pereopods 2–3 dactylus present. Pereopod 4 dactylus absent. Pereopods 5–7 dactylus not denticulate, with unguis and secondary unguis; secondary unguis two-thirds length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 with suture at midlength.

8.0–10.5 mm.

Male. Head and pereonites 1–3 as for female. Pereonite 4 about 10 times as long as pereonite 3; without dorsal elevations, constricted for the first quarter length. Pereonites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7, without dorsal elevations, with small lateral wings, apex blunt.

Antenna 1 extending past the end of the second peduncular article of antenna 2; aesthetascs present laterally and distally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles and claw; with a row of scales along full length.

Mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of unequal length. Pleopod 2 appendix masculina with ridge on posterior face, curved, extending quarter length past the endopod, apex simple. Penial plate widened proximally, tapering distally, apex notched.

7–10 mm.

Distribution. Australia: New South Wales, Victoria, Tasmania, South Australia; subtidal to 21 m depth.

Remarks. Neastacilla deducta was described from South Australia from a single male by Hale (1925). He later described a female and 'subadult' male of *Astacilla vicaria* from eight syntypes from New South Wales (Hale, 1946). The distinction between the two species has never been clear. Hale (1946) argued that the structure of the second antenna, including the number of flagellar articles; eye size and expansion of pereonite 1 were differences. Examination of type material of *N. vicaria* and *A. deducta* and of other material at Museum Victoria has shown that the two are synonymous, a view shared by Poore et al. (2002). The type males of *A. vicaria* males were all immature, some up to 1 or 2 moults from maturity as shown by the underdeveloped appendix masculina. Juveniles and females always possess two antenna 2 flagellar articles; only mature males have a flagellum of 3 articles. This condition is also seen in *N. coonabooloo* sp. nov.

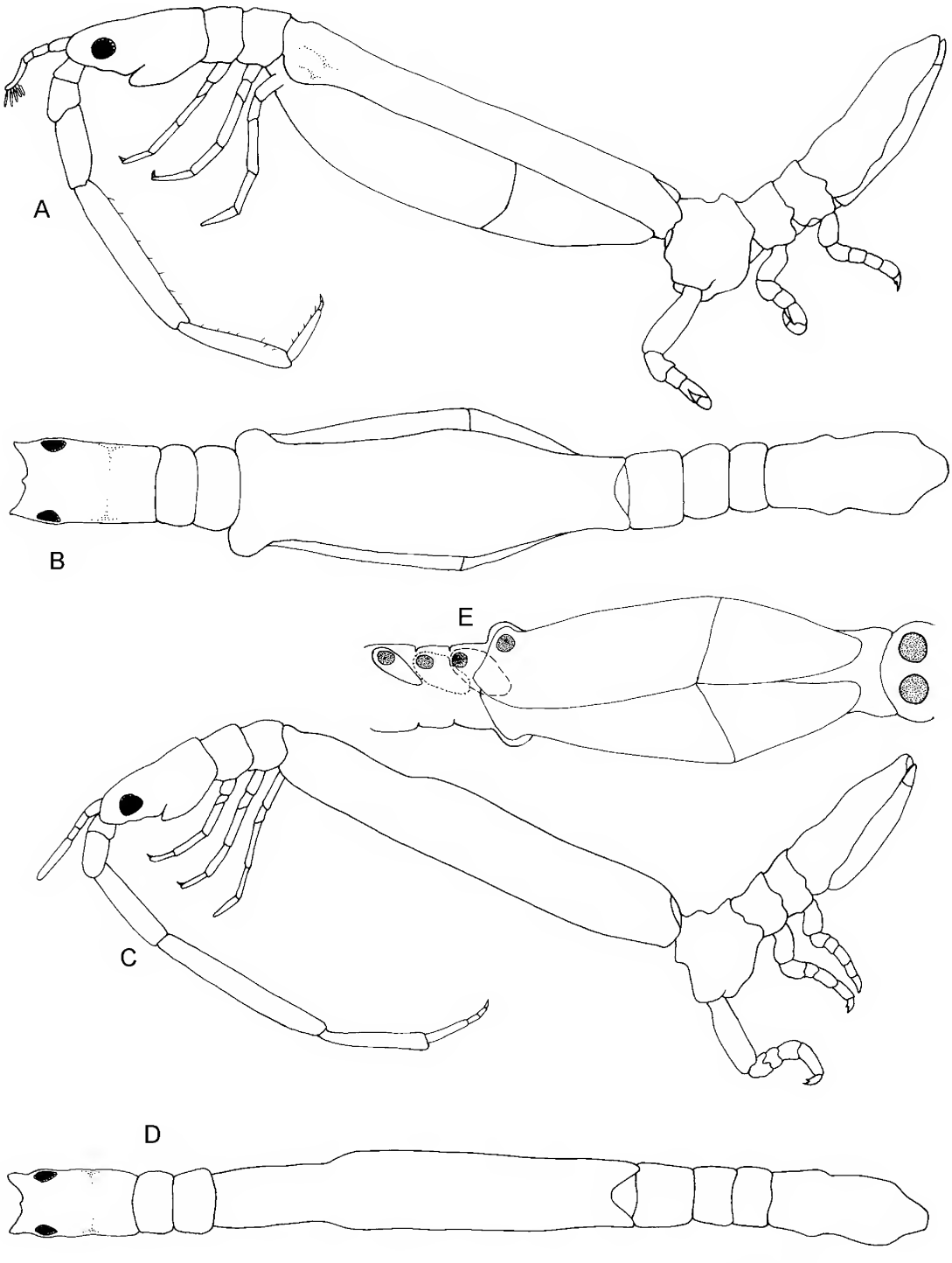

Figure 4. *Neastacilla deducta* Hale, 1924, female (NMV J40673): A, lateral view; B, dorsal view; E, ventral view with oostegites. Male (NMV J40674): C, ventral view; D, dorsal view. Scale = 1.0 mm.

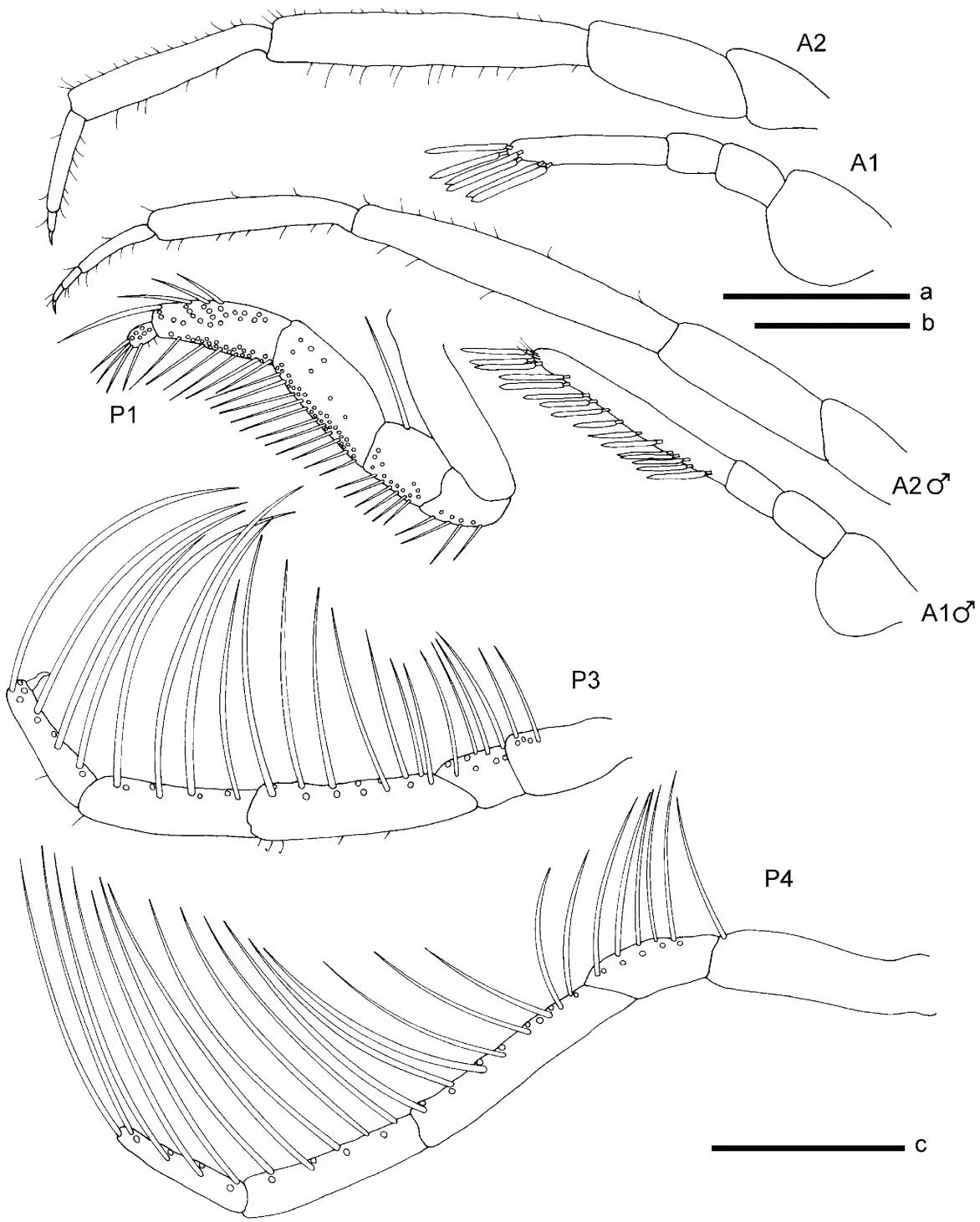

Figure 5. *Neastacilla deducta* Hale, 1924, female (NMV J40673): A1, A2, P1, P3, P4. Male (NMV J40674): A1♂, A2♂. Scales: a (A1, A1♂) = 0.5 mm; b (A2, A2♂) = 1.0 mm; c (P1, P3) = 0.5 mm.

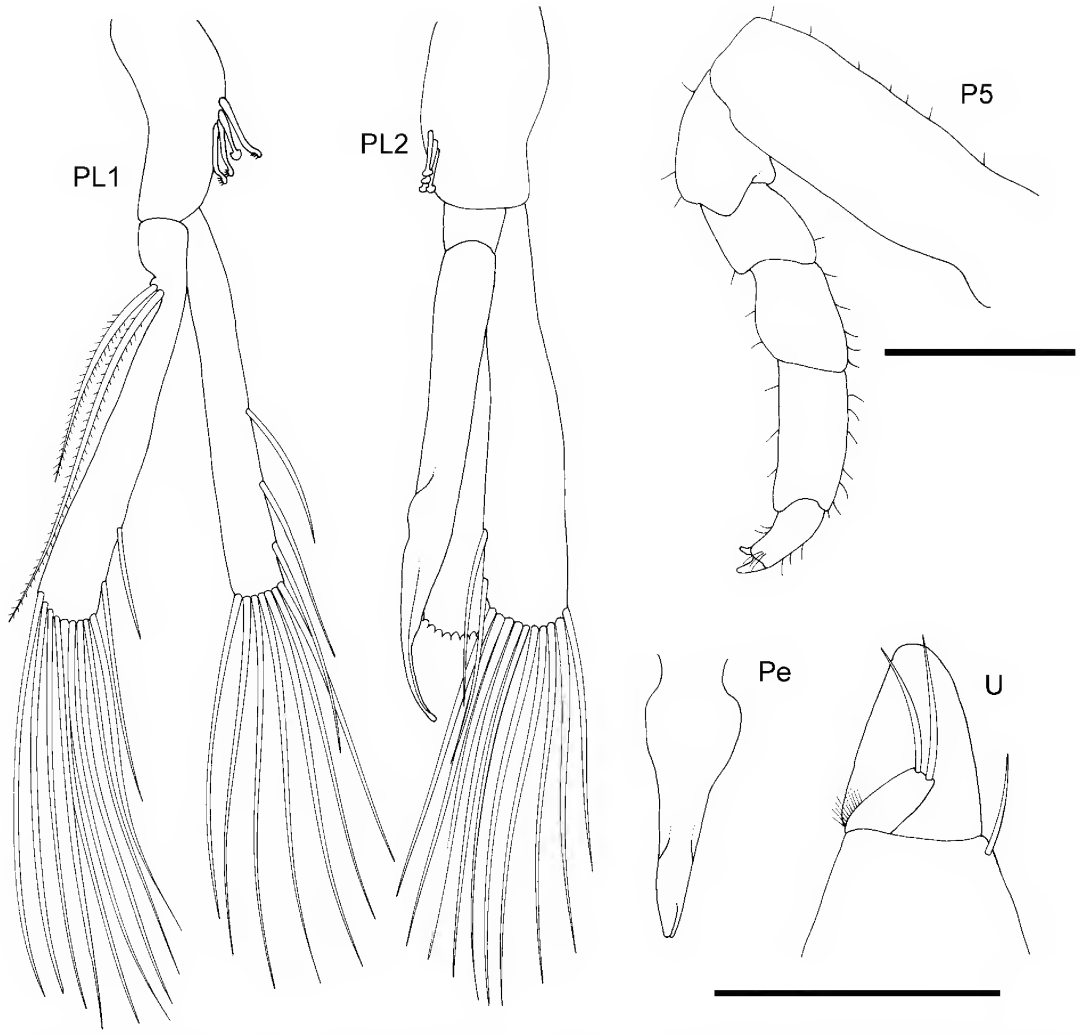

Figure 6. *Neastacilla deducta* Hale, 1924, male (NMV J40674): PL1, PL2, Pe. Female (NMV J40673): P5, U. Scales a (P5) = 0.5 mm; b (PL1, PL2, Pe, U) = 0.5 mm.

Neastacilla deducta looks most similar to *N. monoseta* and *N. kanowna* sp. nov. It is distinguished from *N. monoseta* by the blunt pleotelson without lateral expansions and from *N. kanowna* by the presence of a shallow dorsolateral groove between the head and pereonite 1, which is incised laterally.

Neastacilla fusiformis (Hale)

Astacilla fusiformis Hale, 1946:185–186, fig. 14.—Hurley, 1961: 264.—Monod, 1970: 1139.

Diagnosis of male. Eyes small and subtriangular. Head with small dorsal elevation anterior to eyes and pair of larger dorsal elevations slightly posterior to eyes, lateral margin of head and pereonite 1 not incised. Pereonites 1–3 with single dorsal elevation and pair of lateral elevations. Pereonite 4 7 times as long as pereonite 3, anteriorly restricted in dorsal view, with pair of dorsal elevations and 2 pairs of dorsolateral elevations at midlength, with single dorsal elevation and pair of dorsolateral elevations posteriorly. Pereonites 5–7 with pair of dorsal evelations and pair of lateral elevations. Pleon slightly longer than pereonites 5–7 combined, with 3 pairs of dorsal elevations and lateral elevations, 2 pairs of lateral wings present, apex acute. 5 mm.

Female. Undescribed.

Distribution. New Zealand, North Island, Huaraki Gulf; subtidal.

Remarks. Neastacilla fusiformis was described by Hale (1946) from a single male specimen taken in a tow net from the Hauraki Gulf, New Zealand. This specimen is similar to the

male of *N. tuberculata* and *N. sheardi*, however neither of these species possesses a pereonite 4 that is anteriorly constricted in dorsal view or sharp dorsal and dorsolateral elevations.

Neastacilla inaequispinosa (Guiler)

Figures 7–8

*Astacilla inaequispinos*a Guiler, 1949: 49–53, figs 3, 4.—Guiler, 1952: 24.—Monod, 1970: 1139.

Astacilla unicornis Guiler, 1949: 53–55, fig. 5.—Guiler, 1952: 24.—Monod, 1970: 1139–1140.

Astacilla derwenti Guiler, 1949: 56–57, fig. 6.—Guiler, 1952: 24.—Monod, 1970: 1139–1140.

Astacilla oculata Guiler, 1949: 59–61, fig. 7.—Guiler, 1952: 24.—Monod, 1970: 1139–1140.

Neastacilla inaequispinosa.—Poore et al., 2002: 259.

Material examined. Syntypes of *Astacilla inaequispinosa* Guiler, 1949. Tas., N end of D'Entrecasteaux Channel, TMG76a (male), TMG76b (1 specimen).

Holotype of *Astacilla derwenti* Guiler, 1949. Tas., N end of D'Entrecasteaux Channel, TM (not registered).

Holotype of *Astacilla oculata* Guiler, 1949. Tas., N end of D'Entrecasteaux Channel, TM (not registered).

Holotype of *Astacilla unicornis* Guiler, 1949. Tas., N end of D'Entrecasteaux Channel, TM (not registered).

Australia: **Vic.** Port Phillip Bay, 38°17.6'S, 144°42.3'E, 17 m, 4 Mar 1991, NMV J39217 (1 female, 6.4 mm), NMV J40691(male, 8 mm) NMV J40695 (1 male, 6 mm). Western Bass Strait, 39°26.3'S, 143°06.8'E, 115 m, 21 Nov 1981, NMV J8843 (1 female, 7.0 mm; 2 males, 7 mm); 39°21.0'S, 143°06.0'E, 101 m, 10 Oct 1980, NMV J8844 (1 female, 6.5 mm); 39°06.0'S, 143°21.0'E, 59 m, 8 Oct 1980, NMV J8837 (1 immature male, 5.5 mm); 39°20.0'S, 143°34.0'E, 95 m, 10 Oct 1980, NMV J8842 (1 male, 10 mm). Western Port, 38°26.48'S, 145°13.03'E, 23 m, 25 Nov 1973, NMV J1014 (1 female, 10.5 mm; 1 immature male, 8 mm); 38°21.39'S, 145°14.03'E, 16 m, 25 Mar 1965, NMV J1011 (1 male, 8.5 mm; 1 immature male, 7 mm). 9.5 km SW of Port Albert, 38°44.0'S, 146°37.0'E, 9 m, 22 Nov 1983, NMV J12580 (1 female, 10.5 mm). **Tas.** Central Bass Strait, 40°31.1'S, 145°04.0'E, 29 m, 3 Nov 1980, NMV J8841 (2 females, 10–11 mm; 1 immature male, 8 mm).

Description of female. Head with a dorsal elevation between the eyes; anterolateral margins angular; rostral point present; lateral margin of head and pereonite 1 not incised. Pereonite 1 with small dorsal elevation. Pereonites 2 and 3 progressively wider, with small dorsal elevations, with small anterolateral extensions present. Pereonite 4 about 6 times as long as pereonite 3; with a dorsal elevation at third length and an elevation on the posterior dorsal margin, anterior anterolateral margins rounded and extended, widest anteriorly. Pereonites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7; without dorsal elevations, with small lateral wings, tapered to a narrow rounded apex.

Eyes large and round. Antenna 1 reaching to the end of the second peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles ending with claw, with 2 rows of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 12 distal robust setae. Maxilla 2 mesial lobe with 20 plumose setae, middle lobe with 4 setae, lateral lobe with 3 setae. Maxillipedal endite with 8 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, articles 3 and 4 with mesial and lateral setal rows, article 5 with mesial and distal setae.

Pereopod 1 propodus as long as carpus; dactylus slightly longer than wide, without unguis. Pereopods 2–4 with small dactylus. Pereopods 5–7 dactylus not denticulate, with unguis and secondary unguis; secondary unguis half length of primary unguis. Uropodal exopod with 2 setae of unequal length. Oostegite 4 with sutured small posterior lobe.

6.5–11 mm.

Male. Head and pereonite 1 similar to female. Pereonites 2 and 3 without dorsal elevations. Pereonite 4 about 11 times as long as pereonite 3, constricted for the first quarter length, with a posterodorsal curved elevation. Pereonites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon length greater than combined lengths of pereonite 5–7, with a pair of small dorsal elevations, with lateral wings, tapering to a narrow rounded apex.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of equal length. Pleopod 2 appendix masculina with ridge on posterior face, with tufts of fine setae at three-quarters length, curved, extending quarter length past endopod, apex simple. Penial plate proximally widened, straight, apex simple.

6.0–10.5 mm.

Distribution. Australia: Victoria, Tasmania; subtidal to 115 m depth.

Remarks. This species was briefly described by Guiler (1949) along with three others from the same locality that are synonymous. The similarity between Guiler's specimens, two of *A. inaequispinosa* and one of each of the others, was first correctly noted by Lew Ton (unpublished) who attributed the alleged specific differences to uneven mounting and illustrations of the material, and incorrect differentiation of males, females and juveniles. The large dorsal elevation between the eyes and the lack of an incision in the groove between the head and pereonite 1 most easily distinguishes *N. inaequispinosa* from other species of *Neastacilla*. Also, the shape of the pleotelson, the dorsal elevations on pereonites 1–4 of the female and the posterior dorsal elevation on pereonite 4 of both males and females are key characteristics.

Neastacilla kanowna sp. nov.

Figures 9–11

Material examined. Holotype. Australia: Vic., Oberon Bay, 39°04.2'S, 146°19.4'E, 21 m, 5 Feb 1982, NMV J3418 (1 female, 14 mm).

Paratypes. Australia: **Vic.** type locality, NMV J3213 (2 females, 15–16 mm; 2 males, 13.5–15 mm), NMV J3214 (1 male, 14 mm), NMV J40679 (1 male, 10.5 mm), NMV J40680 (6 females, 13–15 mm; 7 males, 11–15.5 mm; 2 immature females, 9.0–9.5 mm; 1 immature male, 11 mm). Swan Bay, 38°14.0'S, 144°39.0'E, 4 m, 26 Feb 1991, NMV J20908 (1 female, 13 mm). Eastern Bass Strait, 38°15.0'S, 147°22.5'E, 16 m, 31 Jul 1983, NMV J8820 (1 female, 13.5 mm; 1

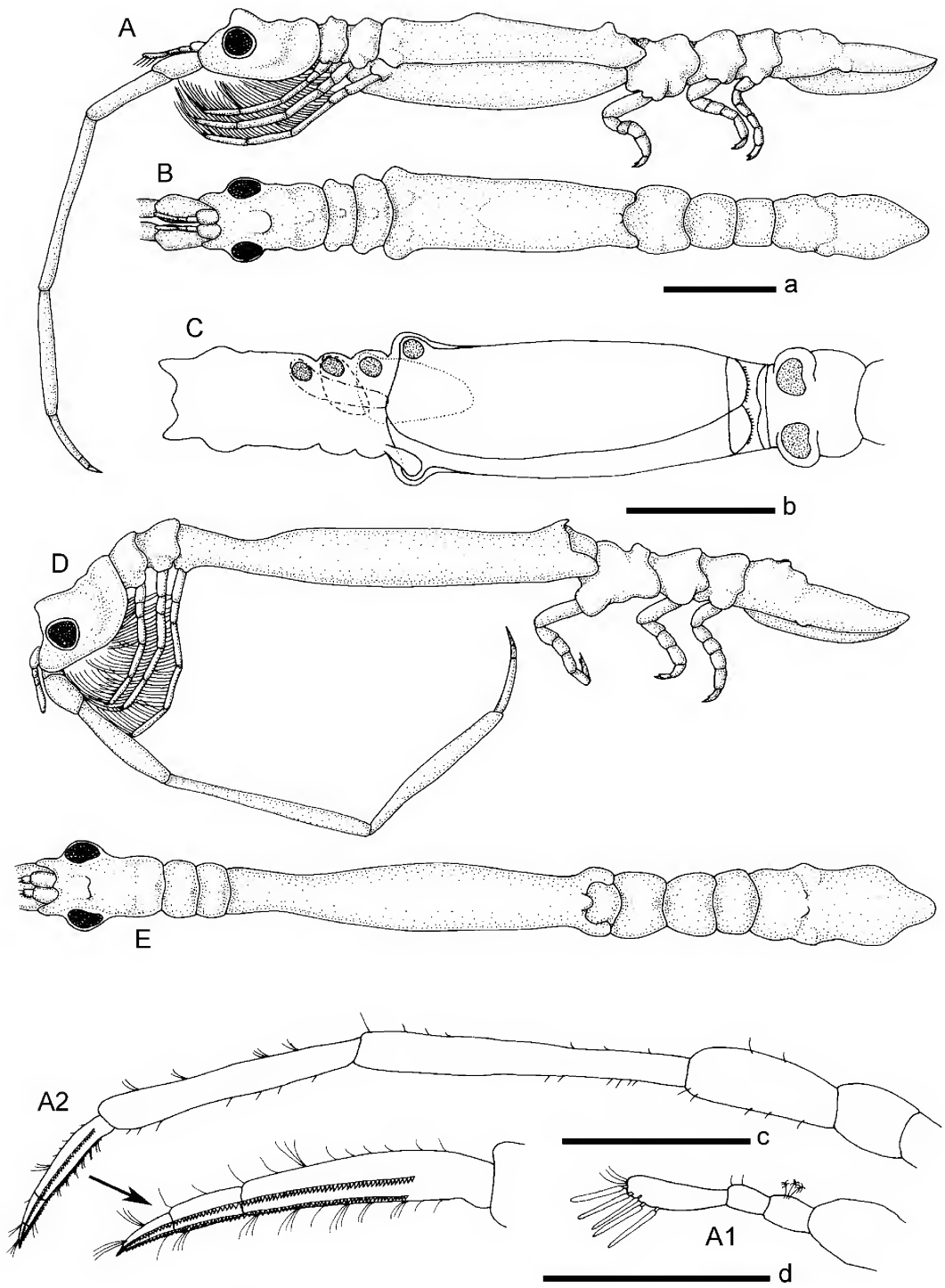

Figure 7. *Neastacilla inaequispinosa* (Guiler, 1949), female (NMV J39217): A, lateral view; B dorsal view; C, ventral view with oostegites; A1, A2. Male (NMV J40691): D, lateral view; E, ventral view. Scales: a (A, B) = 1 mm; b (C) = 1.0 mm; c (A2) = 1.0 mm; d (A1) = 0.5 mm.

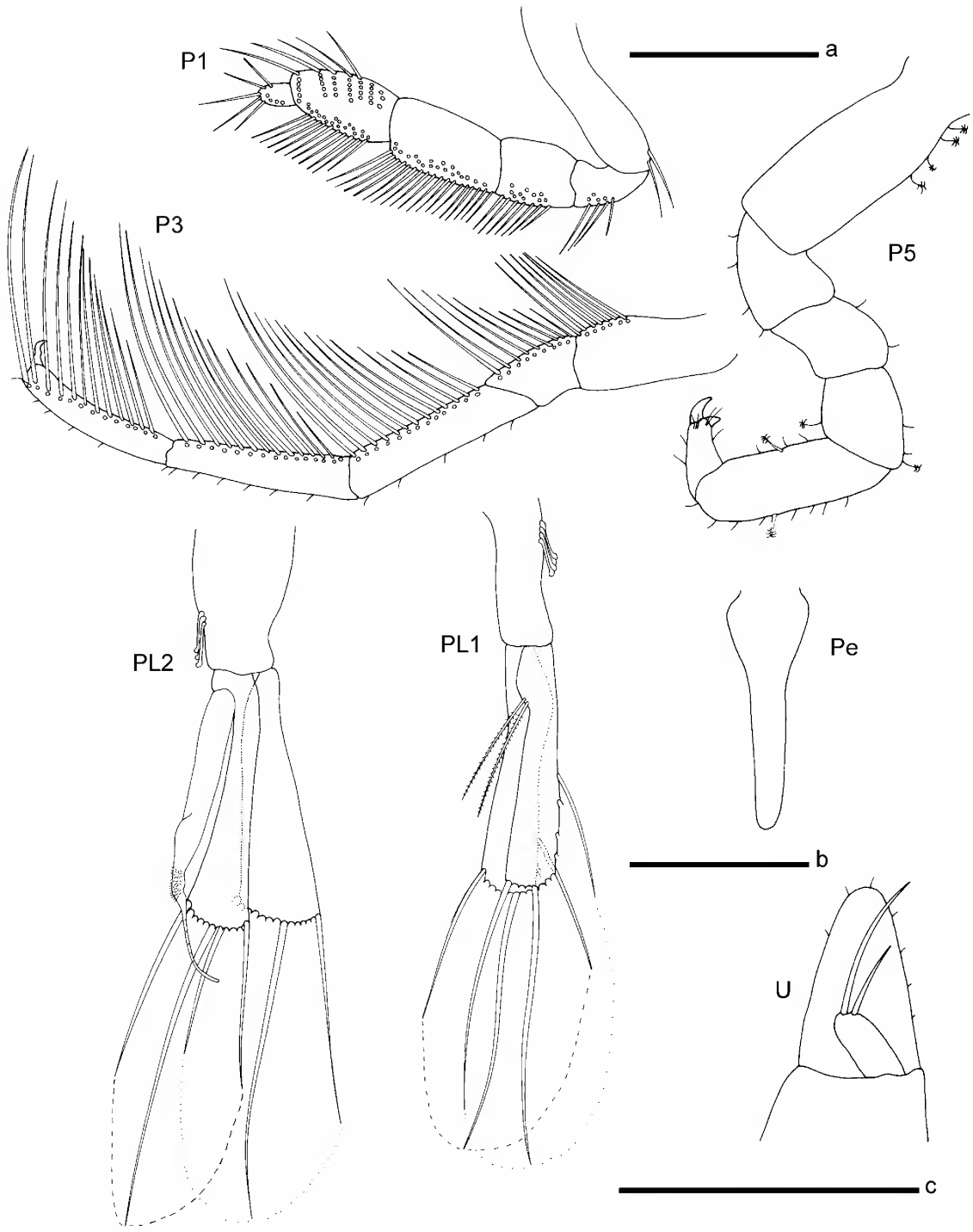

Figure 8. *Neastacilla inaequispinosa* (Guiler, 1949), female (NMV J39217): P1, P3, P5, U. Male (NMV J40691): PL1, PL2, Pe. Scales: a (P1, P3) = 0.5 mm; b (PL1, PL2, Pe) = 0.5 mm; c (U) = 0.5 mm.

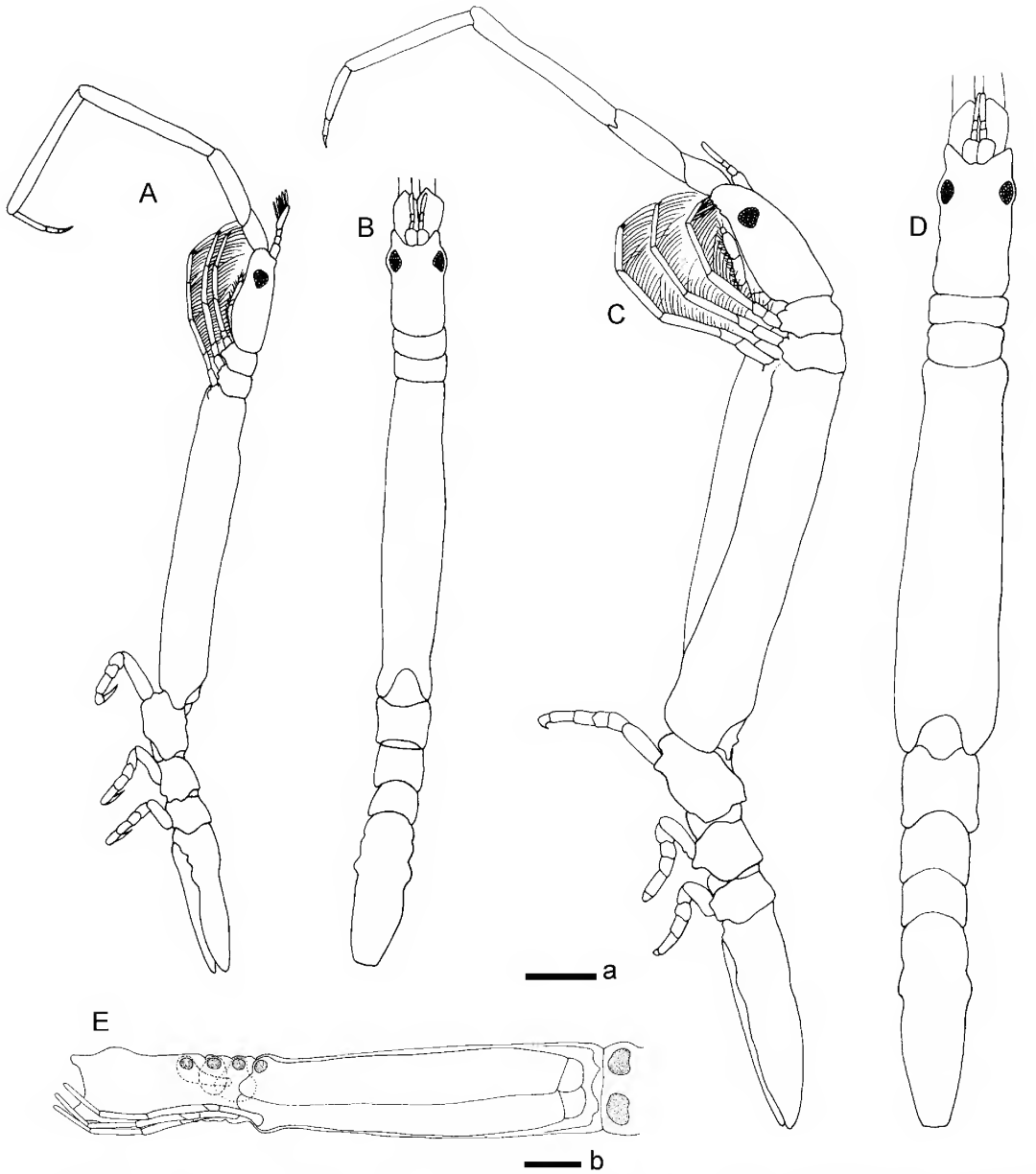

Figure 9. *Neastacilla kanowna* sp. nov., female holotype (NMV J3418): A, lateral view; B, dorsal view; E, ventral view with oostegites. Male (NMV J40679): C, lateral view; D, dorsal view. Scales = a (A–D) = 1.0 mm; b (E) = 1.0 mm.

male, 11 mm; 1 immature female, 10 mm; 1 immature male stage 1, 7.5 mm). **Tas.** Central Bass Strait, off Three Hummock I., 40°31.1'S, 145°04.0'E, 29 m, 3 Nov 1980, NMV J8819 (1 male, 15.5 mm). **SA.** Flinders I., 33°40.50'S, 134°22.0'E, 20 m, 19 Apr 1985, NMV J16578 (1 male, 15 mm).

Description of female. Head without dorsal elevation, anterolateral lobes rounded, small rostral point present; lateral margin of the head and pereonite 1 not incised. Pereonite 1without anterolateral expansion. Pereonites 2 and 3 similar width, without dorsal elevations, without lateral extensions. Pereonite 4 about 9 times as long as pereonite 3, without dorsal elevations, small anterolateral extensions present, slightly wider than pereonites 2 and 3. Pereonites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7, without dorsal elevations, with small proximal lateral wings, apex truncated.

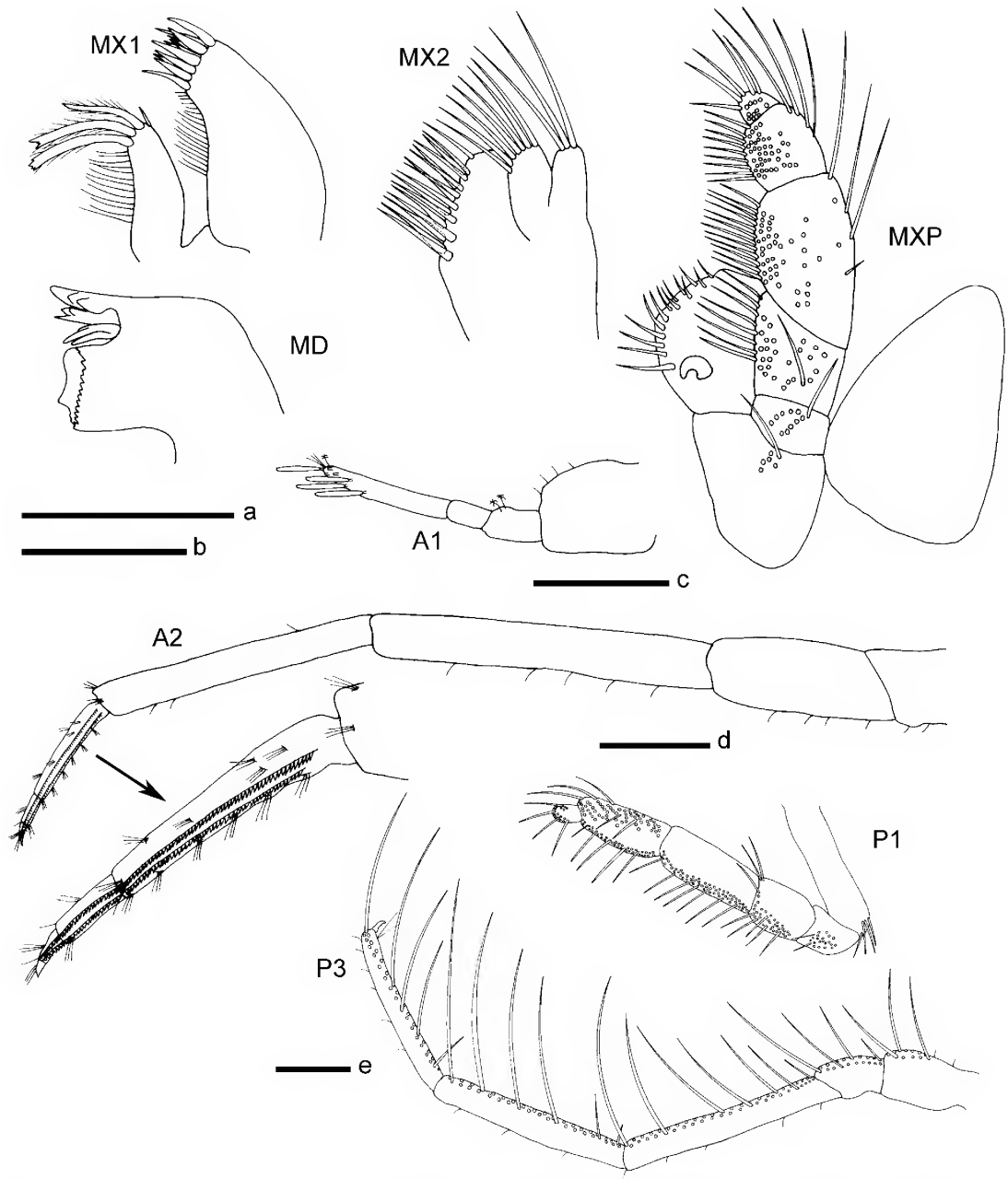

Figure 10. *Neastacilla kanowna* sp. nov., female holotype (NMV J3418): left MXP, MX1, MX2, MD, A1, A2, P1, P3. Scales: a (MX1, MX2, MD) = 0.5 mm; b (MXP) = 0.5 mm; c (A1) = 0.5 mm; d (A2) = 0.5 mm; e (P1, P3) = 0.5 mm)

Eyes small and subtriangular. Antenna 1 reaching to the distal edge of the second peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles plus claw, with 2 rows of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 11 robust setae. Maxilla 2 mesial lobe with 22 setae; middle lobe with 7 setae; lateral lobe with 3 setae. Maxillipedal endite with 14 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows; article 3 with mesial setal and lateral setal

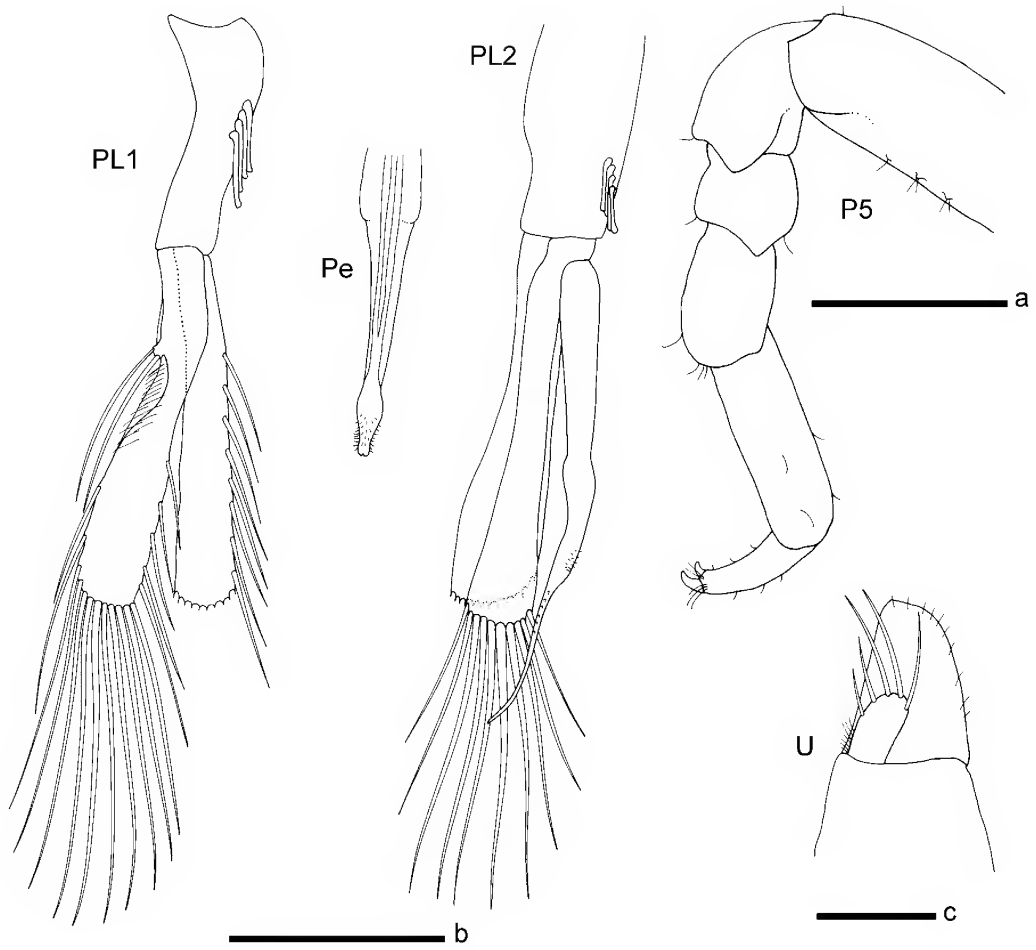

Figure 11. *Neastacilla kanowna* sp. nov., female holotype (NMV J3418): U. Male (NMV J40679): PL1, PL2, Pe. Scales: a (P5) = 0.5 mm; b (PL1, PL2, Pe) = 0.5 mm; c (U) = 0.25 mm.

rows; articles 4 and 5 with mesial and lateral setal rows; article 5 with mesial and distal setae.

Pereopod 1 propodus shorter than carpus; dactylus almost twice as long as wide, without unguis. Pereopods 2–4 with dactylus. Pereopods 5–7 dactylus not denticulate, with unguis and secondary unguis; secondary unguis greater than half length of primary unguis. Uropod exopod with 5 setae. Oostegite 4 with sutured small posterior lobe.

10–16 mm.

Male. Smaller than female but similar morphologically. Pereonites, mouthparts, pereopods all as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of equal lengths. Pleopod 2 appendix masculina with ridge on posterior face, with fine setae, curved, and extending quarter length past endopod, apex simple. Penial plate widened proximally, distally bulbous with fine setae, apex with shallow notch.

7.5–15 mm.

Distribution. Australia: Victoria, Tasmania, South Australia; subtidal.

Etymology. "Kanowna" is an Australian Aboriginal name for the sea.

Remarks. This species is most easily distinguished from all other species of *Neastacilla* by its large adult size (around 15 mm), unornamented body and truncate pleotelson. The presence of five setae on the uropodal exopod distinguishes this species from all other Australian species of *Neastacilla*, which generally have two or three apical setae.

Neastacilla lawadi sp. nov.

Figures 12–13

Material examined. Holotype. Australia: WA, between Dampier and Port Hedland, 19°48.8'S, 117°52.2'E, 52 m, 2 Sep 1983, NMV J16933 (1 female, 8 mm).

Paratypes Australia: **NT.** Oxley Island, (W side), 11°00.0'S, 132°49.0'E, 14 m, 21 Oct 1982, NMV J16580 (2 females, 5 mm). NT, station unknown, Oct 1982, NMV J16581 (1 female, 9 mm; 1 male, 6 mm). **SA.** upper Spencer Gulf, NMV J16614 (1 female, 7.5 mm); E of Lowly Point, 33°00.0'S, 137°49.5'E, 18 m, Feb 1986, NMV J16610 (1 female, 7.5 mm); N of Fairway Bank, 33°02.4'S, 137°45.0'E, 18 m, Feb 1986, J16611 (1 female, 8 mm). **WA.** Between Dampier and Port Hedland, 19°37.00'S, 118°53.00'E, 30 m, 3 Jun 1983, NMV J16634 (1 male, 5.5 mm); 19°05.82S, 118°56.7'E, 82 m, 14 Feb 1983, NMV J16669 (3 females, 7.5–8.5 mm; damaged juvenile 5.5 mm; manca 1 3.5 mm); 19°48.8'S, 117°52.2'E, 52 m, 2 Sep 1983, NMV J16660 (1 female 7.5 mm); 19°29.0'S, 118°53.2'E, 40 m, 12 Feb 1983, NMV 16931 (1 female 7.5 mm); 19°37.0'S, 118°53.0'E, 30 m, 3 Jun 1983, NMV 16634 (3 mature females, 5–6.5 mm; 2 immature females, 5 mm; 1 male, 5 mm).

Description of female. Head with 2 large dorsal elevations and 2 small elevations posteriorly; anterolateral margins angular; rostral point present; lateral margin of head and pereonite 1 not incised. Head and pereonite 1 extended anterolaterally. Pereonite 1 with small paired tuberculate dorsal elevations. Pereonites 2 and 3 with small paired tuberculate dorsal elevations and lateral tuberculate elevations, small lateral extensions present. Pereonite 4 about 9 times as long as pereonite 3, with dorsal and dorsolateral tuberculate elevations anteriorly, large paired dorsal elevations midlength, anterolateral margins rounded and extended. Pereonites 5–7 progressively smaller posteriorly, with some dorsal tuberculation. Pleon length greater than combined lengths of pereonites 5–7, with 2 sets of lateral wings, apex subacute.

Eyes small and suboval. Antenna 1 extending to midlength of third peduncular article of antenna 2; aesthetascs present distally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 2 articles ending with a claw, with row of scales along full length.

Maxilla 1 with 3 terminal setae; lateral lobe with 10 distal robust setae. Maxilla 2 mesial lobe with 22 plumose setae, middle lobe with 3 setae, lateral lobe with 3 setae. Maxillipedal endite with 12 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, articles 3 and 4 with mesial and lateral setal rows, article 5 with distal setae.

Pereopod 1 propodus slightly shorter than carpus; dactylus longer than wide, without unguis. Pereopods 2–4 with small dactylus. Pereopods 5–7 dactylus not denticulate, with unguis and secondary unguis; secondary unguis setiform and slender and only slightly smaller than primary unguis. Uropodal exopod with 2 setae of equal length. Oostegite 4 with a sutured small posterior lobe.

5–9 mm.

Male. Ornamentation not as pronounced as for female. Head with slight elevation and pereonites 1 to 3 with some tuberculation. Pereonite 4 about 10 times as long as pereonite 3; without dorsal elevations except for posterodorsal curved elevation. Pereonites 5–7 progressively smaller; pereonite 5 with a dorsal curved elevation; pereonites 6 and 7 without dorsal elevations. Pleon longer than combined lengths of pereonites 5–7, with 2 sets of lateral wings, apex subacute.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose setae of unequal length. Pleopod 2 appendix masculina with ridge on posterior face, curved, extending third length past endopod, apex simple. Penial plate widened proximally, distally tapered, apex simple.

5–7 mm.

Distribution. Australia: Western Australia, Northern Territory, South Australia; subtidal to 82 m depth.

Etymology. "Lawadi" is an Australian Aboriginal word in the Gooniyandi dialect from north-western Australia where this species was first collected. It means "shoulder" and refers to the rounded anterolateral extensions on pereonite 4 of the female.

Remarks. This species resembles *Neastacilla attenuata* Hale, 1946 from New South Wales and the eastern coasts of Australia. However, the shape of the head is the most obvious difference between the two. *N. lawadi* sp. nov. does not have a lateral incision between the head and pereonite 1 and the head is more ventrally expanded and more sculptured. The third peduncular article of antenna 2 in *N. lawadi* sp. nov. is not thickened as in *N. attenuata.* The pleotelson of *N. lawadi* sp. nov. has a posterior dorsal elevation and more pronounced lateral wings. *Neastacilla attenuata* has a slender pleotelson with no elevation and is slightly turned up at the end.

Neastacilla levis (Thomson and Anderton)

Figures 14–15

Astacilla levis Thomson and Anderton, 1921: 114–115, text-fig.—Hurley, 1957: 13–15, figs 50–66.—Hurley, 1961: 264, 281.

Material examined. New Zealand, off the W coast of South Island, 42°25.0'S, 171°06.0'E, 35 m, 5 Mar 1982, NMV J4736 (1 female, 9.5), NMV J40692 (1 female, 10 mm), NMV J40675 (1 male, 9.5 mm).

Description of female. Head without dorsal elevations, anterolateral lobes rounded, rostral point present; lateral margin of head and pereonite 1 incised. Pereonite 1 not extended anterolaterally, with small dorsolateral tuberculate elevations. Pereonite 2 and 3 progressively wider, without dorsal elevations, small lateral extensions present. Pereonite 4 about 7 times as long as pereonite 3; dorsally elevated at first third length, anterolateral margins extended and rounded. Pereonites 5–7 progressively smaller, without dorsal elevations. Pleon length greater than combined lengths of pereonites 5–7, without dorsal elevations, with small lateral wings, apex truncated and notched.

Eyes large and triangular. Antenna 1 extending to the distal edge of second peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles ending in a claw, 2 rows of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 11 distal robust setae. Maxilla 2 mesial lobe with 14 plumose

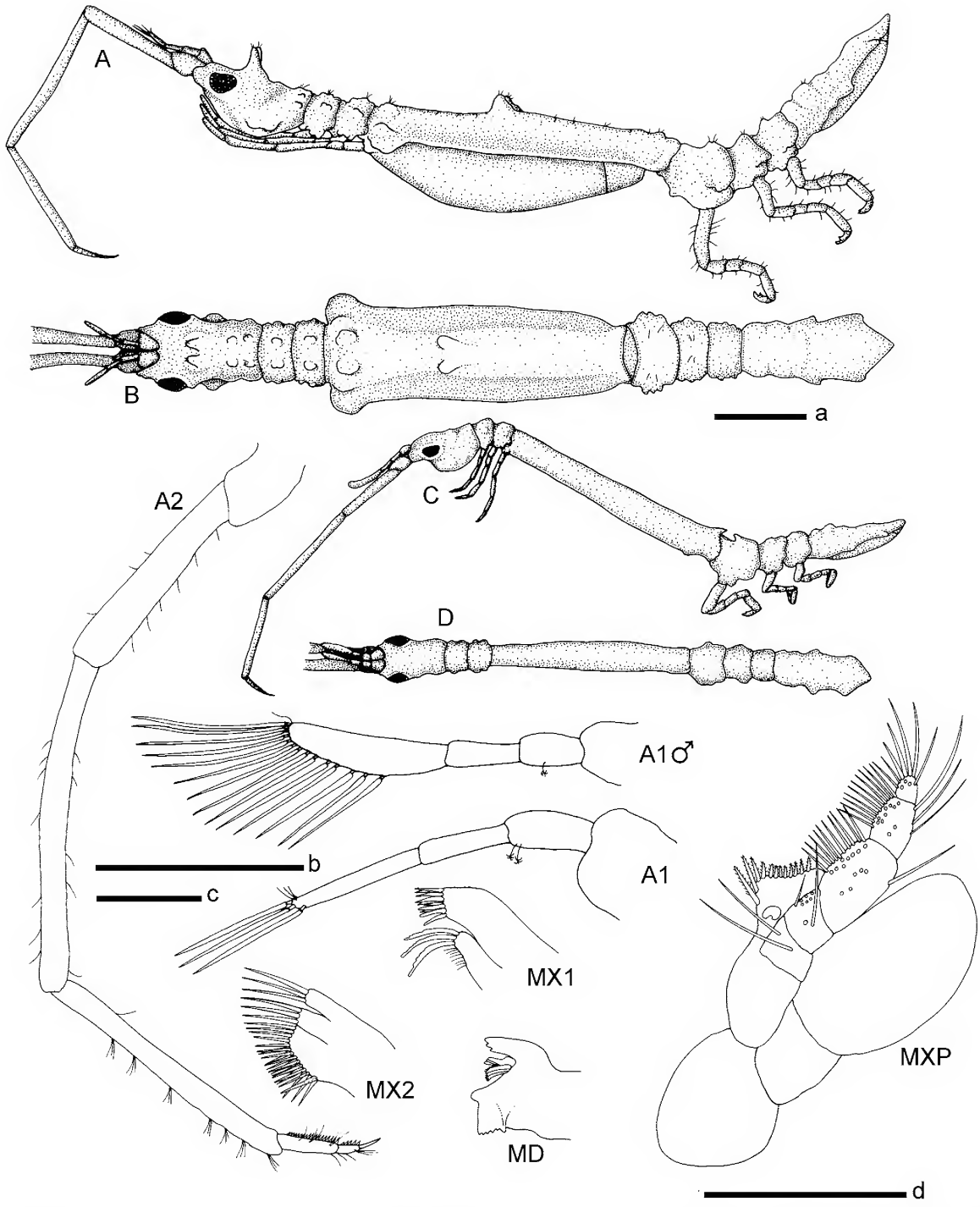

Figure 12. *Neastacilla lawadi* sp. nov., female holotype (NMV J16933): A, lateral view; B, dorsal view; A1, A2, left MXP, MX1, MX2, MD. Male (NMV J16634): C, ventral view; D, dorsal view; A1♂. Scale: a (A–D) = 1.0 mm; b (A1, A1♂) = 0.5 mm; c (A2) = 1.0 mm; d (MXP, MX1, MX2, MD) = 0.5 mm.

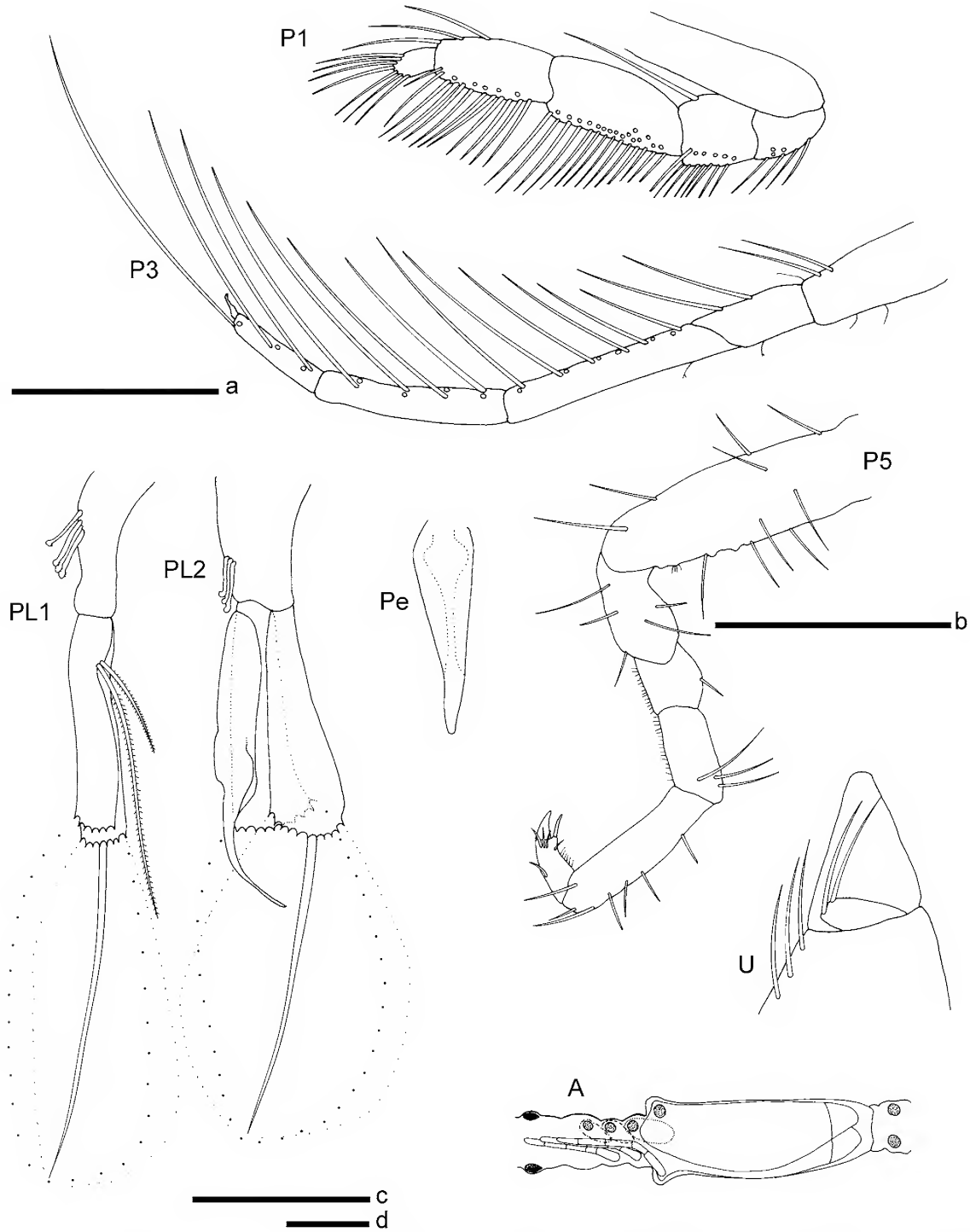

Figure 13. *Neastacilla lawadi* sp. nov., female holotype (NMV J16933): P1, P3, P5, U, A, ventral view. Scales: a (P1, P3) = 0.5 mm; b (P5) = 0.5 mm; c (Pl1, PL2, Pe, U) = 0.5 mm; d (A) = 1.0 mm.

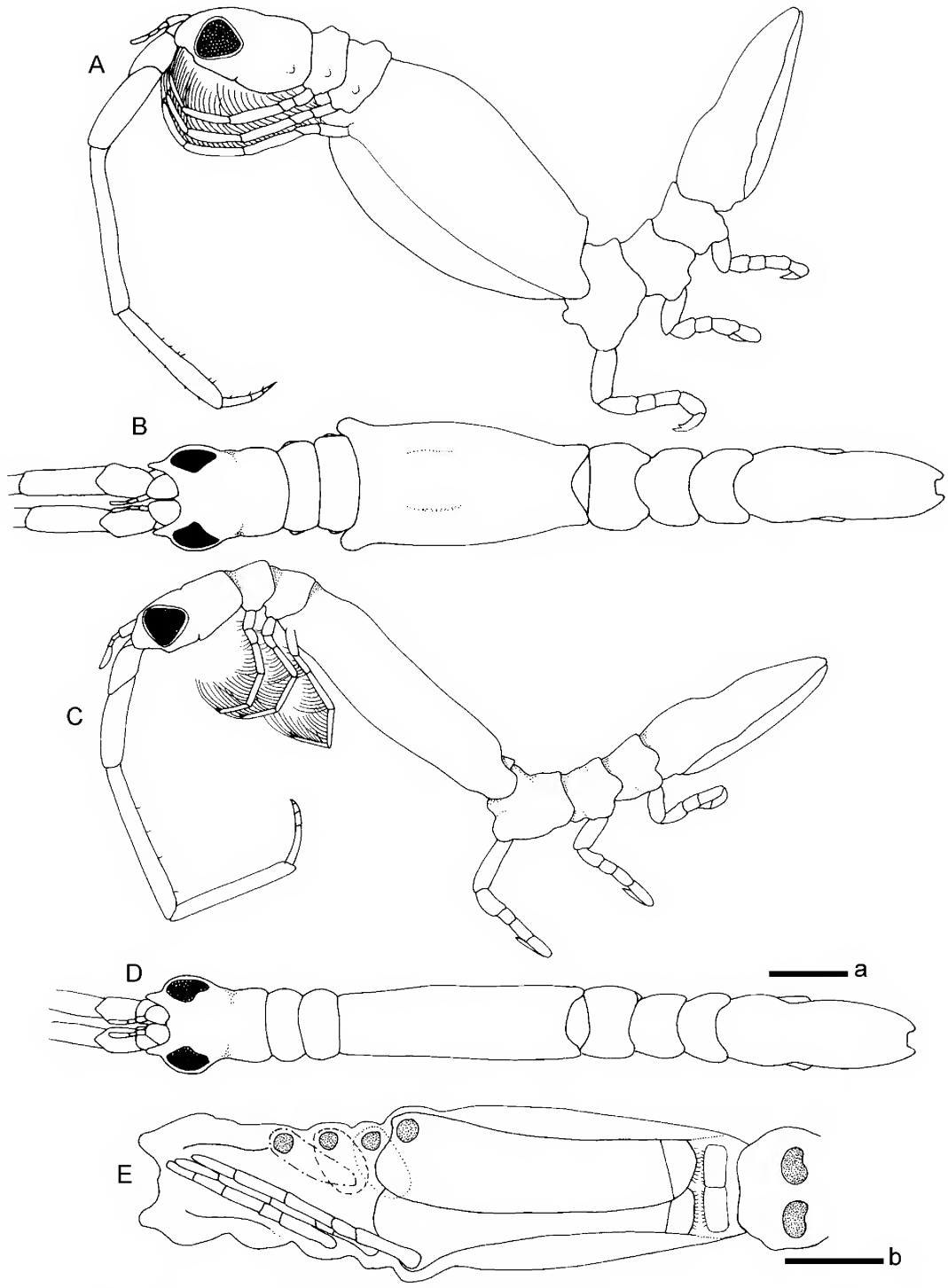

Figure 14. *Neastacilla levis* (Thomson and Anderson, 1921), female (NMV J4736): A, lateral view; B, dorsal view; E, ventral view with oostegites. Male (NMV J40675): C, ventral view; D, dorsal view. Scale: a (A–D) = 1.0 mm; b (E) = 1.0 mm.

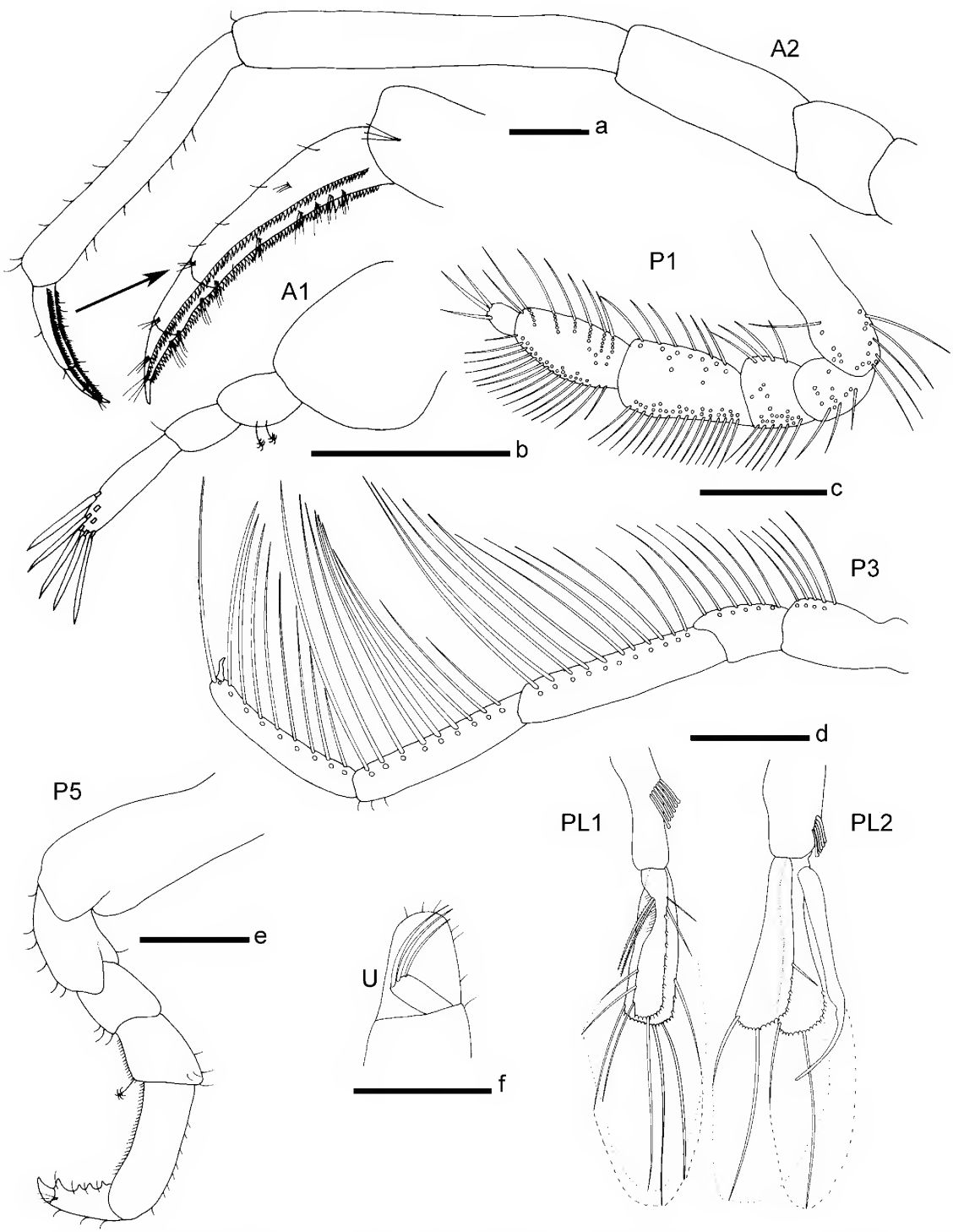

Figure 15. *Neastacilla levis* (Thomson and Anderson, 1921), female (NMV J4736): A1, A2, P1, P3, P5, U. Male (NMV J40675): PL1, PL2, Pe. Scales: a (A2) = 0.5 mm; b (A1) = 0.5 mm; c (P1, P3) = 0.5 mm; d (PL1, PL2) = 0.5 mm; e (P5) = 0.5 mm; f (U) = 0.5 mm.

setae, middle lobe with 5 setae, lateral lobe with 4 setae. Maxillipedal endite with three coupling hooks present; palp article 2 with mesial setal rows, articles 3 and 4 with mesial and lateral setal rows, article 5 with mesial and distal setae.

Pereopod 1 propodus and carpus similar length; dactylus longer than wide, without unguis. Pereopods 2–4 with dactylus. Pereopods 5–7 dactylus with 3 denticulations (see *Remarks*) and setae, with unguis and secondary unguis; secondary unguis about third length of primary unguis. Uropodal exopod with 3 setae of equal length. Oostegite 4 with sutured small posterior lobe.

10–12 mm.

Male. Head ornamentation similar to female. Pereonite 4 about 8 times as long as pereonite 3, without dorsal elevations, anterolateral margins not extended. Pereonites 5–7, Pleon similar to female.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of unequal lengths. Pleopod 2 appendix masculina with ridge on posterior face, curved, extending third length past the endopod, apex simple. Penial plate simple and straight.

10–13 mm.

Distribution. New Zealand; subtidal.

Remarks. First described by Thomson and Anderton (1921) as *Astacilla levis*, only a lateral view of the single female specimen taken off Otago Heads was drawn. The description was brief and relatively uninformative. Hurley (1957) provided further description the species from two males and one female taken from Cook Strait, figuring only the male and not describing the male pleopod 1, female oostegites, maxilla 1, maxilla 2 or mandible. The large triangular eye, shape of the head and pereonite 1 and the truncate, notched pleotelson immediately distinguish this species. Hurley (1957) described the denticulation of pereopods 5–7 as "4–5 small corrugations;" three denticulations were found in all specimens examined for this study so this character must be variable.

Neastacilla macilenta (Hale)

Astacilla macilenta Hale, 1946: 179–182, figs 11–12.—Monod, 1970: 1139.

Neastacilla macilenta.—Poore et al., 2002: 259.

Diagnosis of female. Eyes small and round. Head without dorsal elevations; lateral margins of head and pereonite 1 not incised, extended anterolaterally; unsutured lateral groove below eye present. Pereonites 2–3 without dorsal elevations. Pereonite 4 7 times as long as pereonite 3, without dorsal elevations, anterolateral margins extended and angular. Pleon length longer than pereonites 5–7 combined, 2 pairs of lateral wings, apex bluntly rounded. 8 mm.

Male. Similar to female except for pereonite 4, which is 15 times as long as pereonite 3.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of unequal lengths. Pleopod 2 appendix masculina with ridge on posterior face, curved, not extending past the endopod, apex simple. Penial plate undescribed. 9 mm.

Distribution. Australia: New South Wales.

Remarks. This species is diagnosed using the description of Hale (1946). This species is superficially similar to *Neastacilla. soelae* sp. nov., *N. monoseta* and *N. deducta*. However, *N. soelae* possesses a distinctive long pointed pleotelson and *N. monoseta* possesses a large, angular lateral wings on the pleotelson. The pleotelson of *N. macilenta* is rounded and blunt. *N. macilenta* can be further distinguished from *N. monoseta* and *N. deducta* by the absence of an incision in the suture line between the head and pereonite 1.

Hale (1946) illustrated three lateral plumose setae on the exopod of pleopod 1 in males. In all specimens examined here, there were two lateral plumose setae.

Neastacilla marrimarri sp. nov.

Figures 16–17

Material examined. Holotype. Australia: WA, King George Sound, 35°00.7'S, 118°10.1'E, 25 m, 15 Apr 1984, NMV J16641 (1 female, 6.4 mm).

Description of female. Head with 2 dorsal elevations between eyes, anterolateral margins angular, rostral point absent; lateral margin of head and pereonite 1 not incised. Pereonite 1 with large dorsal elevation and small dorsolateral elevations. Pereonites 2 and 3 with dorsal and dorsolateral elevations, with lateral margins extended. Pereonite 4 about 5 times as long as pereonite 3; with 2 dorsal elevations midlength each with 2 apices, small dorsolateral elevations at midlength, anterior dorsolateral elevations, 2 posterodorsal elevations and 2 posterior dorsolateral elevations, anterolateral margins rounded and extended. Pereonites 5–7 progressively shorter posteriorly, with dorsal and dorsolateral elevations. Pleon similar length to the combined lengths of pereonites 5–7, with 2 sets of lateral wings, apex subacute.

Eyes small and round. Antenna 1 reaching past the second peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles ending with claw; with 2 rows of scales along full length.

Maxilla 1mesial lobe with 3 terminal setae; lateral lobe with 9 distal robust setae. Maxilla 2 mesial lobe with 15 plumose setae, middle lobe with 3 setae, lateral lobe with 3 setae. Maxillipedal endite with 8 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, articles 3 and 4 with mesial and lateral setal rows, article 5 with distal setae.

Pereopod 1 propodus and carpus of a similar length; dactylus longer than wide; without unguis. Pereopods 2–4 with small dactylus. Pereopods 5–7 dactylus denticulate, with unguis and secondary unguis; secondary unguis half size of primary unguis. Uropodal exopod with 2 setae of equal length. Oostegite 4 with a sutured small posterior lobe.

6.4 mm.

Male. Unknown

Distribution. Australia: Western Australia; subtidal.

Etymology. "Marrimarri" is an Australian Aboriginal word in the Nyungar dialect from south-western Australia where this specimen was found. It means "crustacean" or "crab".

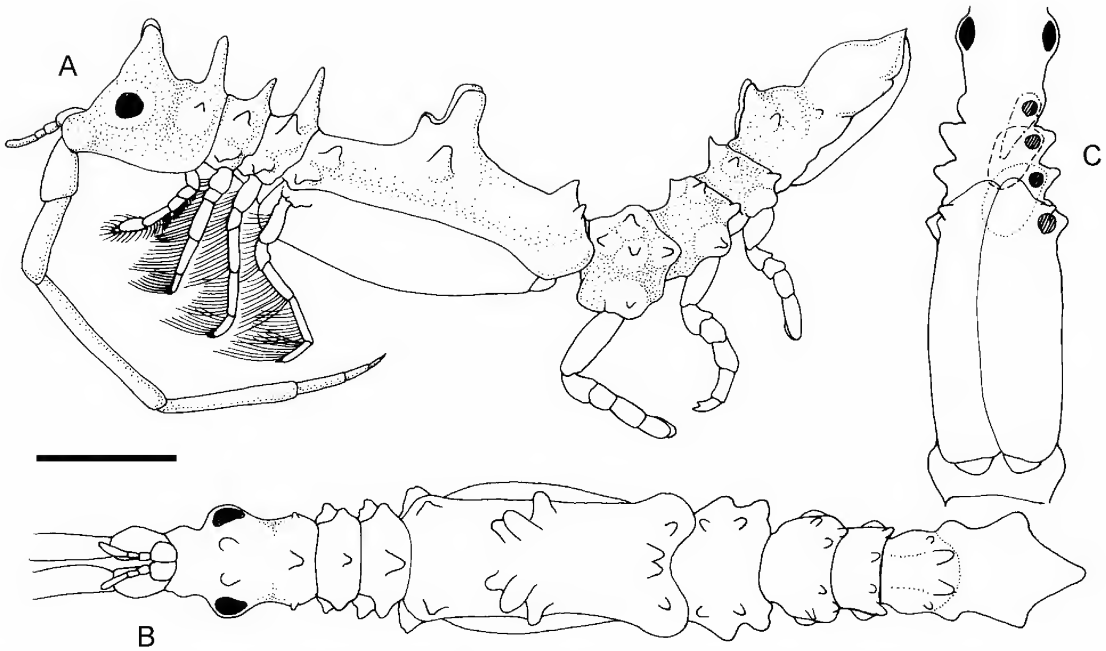

Figure 16. *Neastacilla marrimarri* sp. nov., female holotype (NMV J16641): A, lateral view; B, dorsal view; C, ventral view with oostegites, Scale = 1.0 mm.

Remarks. Even though this species is known only from a single female specimen, it is sufficiently distinct to warrant a new species. Superficially this species resembles *Neastacilla tuberculata* from New Zealand and *N. sheardi* from southern Australia. However, in *N. marrimarri* sp. nov. the dorsal elevation of pereonite 4 is not as pronounced and the lateral margins not expanded to as great an extent as they are in *N. tuberculata*. The ornamentation of pereonite 4 is also arranged differently. *Neastacilla sheardi* has less ornamentation than *N. marrimarri*. Further, the pleotelson of *N. marrimarri* is more narrow, than in *N. tuberculata* and more angular than that of *N. sheardi*.

Neastacilla monoseta (Guiler)

Figures 18–20

Astacilla monoseta Guiler, 1949: 47–49, figs 1, 2.—Guiler, 1952: 24.—Monod, 1970: 1139–1140.

Neastacilla monoseta.—Poore et al., 2002: 259.

Material examined. Australia: **Vic.** Western Port, 38°21.48'S, 145°13.85'E, 15 m, 30 Mar 1965, NMV J1022 (1 female, 10 mm); 38°22.0'S, 145°32.0'E, NMV J1027 (1 female, 15.5 mm; 7 manca 1 individuals), NMV J1028 (1 female, 15 mm); 38°20.67'S, 145°14.74'E, 9 m, 4 Mar 1965, NMV J1018 (immature male, 8 mm); 38°21.0'S, 145°14.0'E, 8 m, 12 Oct 1964, NMV J1017 (1 male, 15 mm; 1 immature male 9 mm); 38°21.39'S, 145°14.03'E, 16 m, 25 Mar 1965, NMV J1023 (1 male, 15.5 mm); 38°21.17'S, 145°14.0'E, 18 m, 29 Mar 1965, NMV J1024 (immature female, 11 mm). Portsea, 38°19.0'S, 144°43.0'E, NMV J1029 (1 female, 17 mm). Bass Strait, 39°01.0'S, 143°22.1'E, 84 m, 31 Jan 1981, NMV J40641 (1 male, 8.5 mm). Eastern Bass Strait,38°18.0'S, 147°37.0'E, 55 m, 31 Jul 1983, NMV J8818 (immature male, 8 mm). Bennison Channel, 38°49.0'S, 146°23.0'E, 6 m, 23 Nov 1983, NMV J12579 (manca 2, 6.5 mm). **Tas.** Central Bass Strait, 39°32.8'S, 144°16.0'E, 18 m, 1 Nov 1980, NMV J8830 (1 female, 13 mm).

Description of female. Head without dorsal elevations, anterolateral lobes rounded, rostral point present; lateral margin of head and pereonite 1 incised. Pereonite 1 anterolaterally extended. Pereonites 2 and 3 without dorsal elevations. Pereonite 4 about 11 times length of pereonite 3, wider than pereonites 2 and 3, anterolateral margins extended and angular. Pereonites 5–7 progressively shorter posteriorly, lateral margins not expanded. Pleon length greater than combined lengths of pereonites 5–7, with 2 sets of lateral wings, apex acute.

Eyes small and round. Antenna 1 reaching just past the distal edge of the second peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half length of the body; flagellum of 2 articles ending with claw, row of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; outer lobe with 10 robust setae. Maxilla 2 mesial lobe with 20 setae; middle lobe with 3 setae; lateral lobe with 3 setae. Maxillipedal endite with 12 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows; article 3 with mesial and lateral setal rows; article 4 with mesial and lateral setal rows; article 5 with mesial and distal setae.

Pereopod 1 propodus and carpus similar length; dactylus almost twice as long as wide, without unguis. Pereopods 2–4 slender, with dactylus. Pereopods 5–7 dactylus not denticulate,

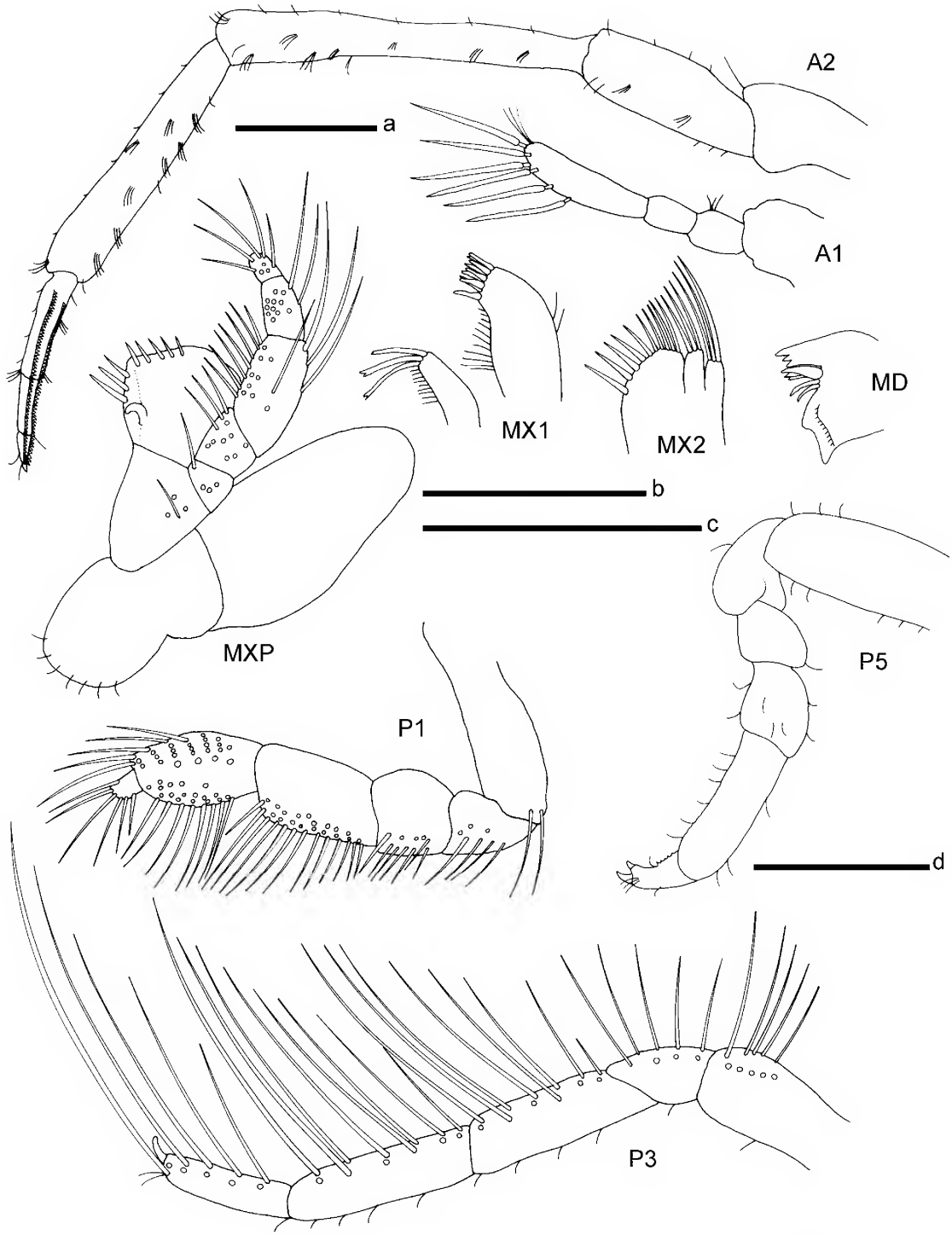

Figure 17. *Neastacilla marrimarri* sp. nov., female holotype (NMV J16641): A1, A2, left MXP, MX1, MX2, MD; P1, P3, P5. Scales: a (A1, A2) = 0.5 mm; b (MP, MX1, MX2, MD, P1) = 0.5 mm; c (P1, P3) = 0.5 mm; d (P5) = 0.5 mm.

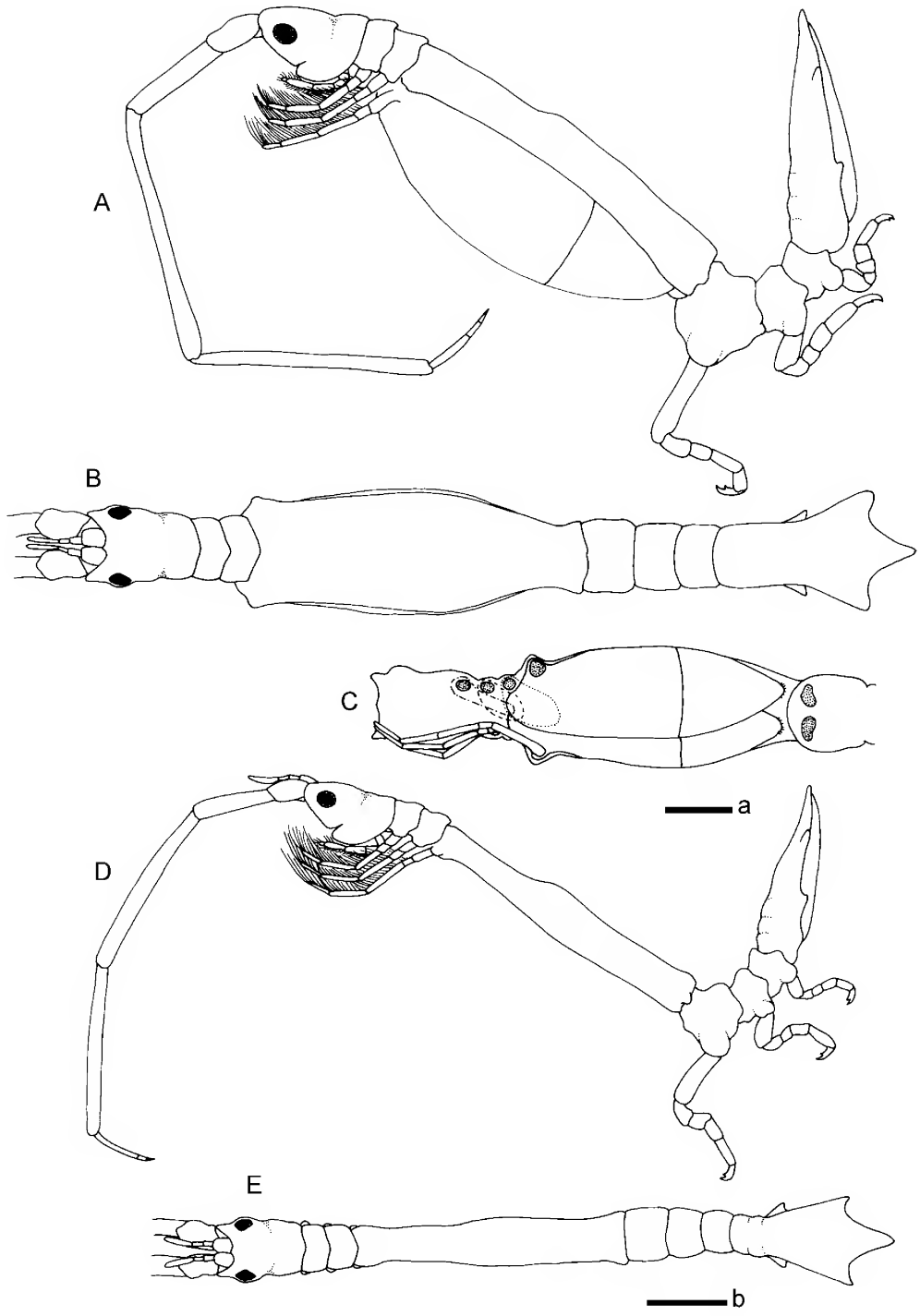

Figure 18. *Neastacilla monoseta* (Guiler, 1949), female (NMV J1022): A, lateral view; B, dorsal view; C, ventral view with oostegites. Male (NMV J40641): D, ventral view; E, dorsal view. Scale: a (A, B, D, E) = 1.0 mm; b (C) = 1.0 mm.

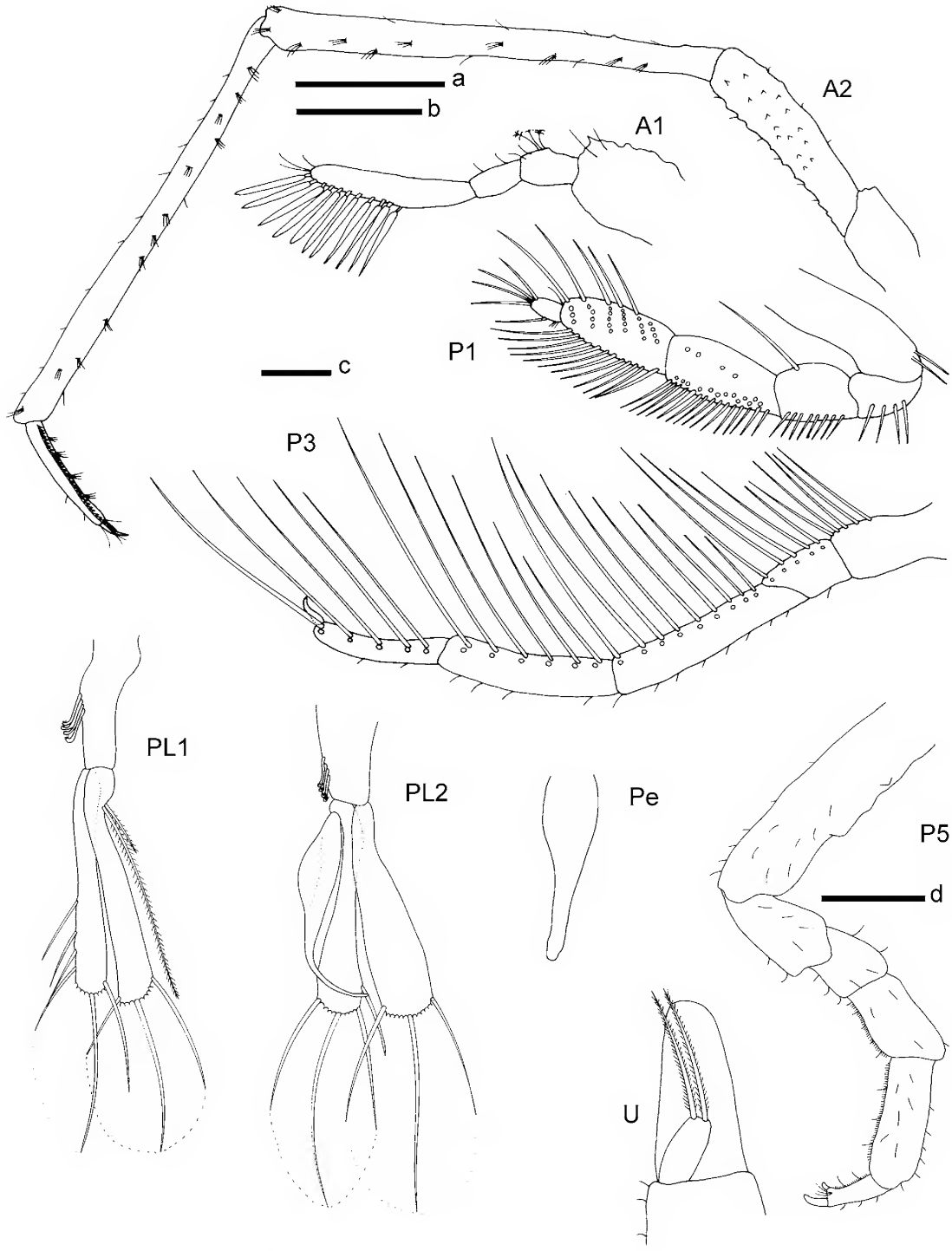

Figure 19. *Neastacilla monoseta* (Guiler, 1949), female (NMV J1022): A1, A2, P1, P3, P5, U. Male (NMV J40641): PL1, PL2, Pe. Scales: a (A1) = 0.5 mm; b (A2) = 1.0 mm; c (P1, P2) = 1.0 mm; d (P5) = 0.5 mm; e (PL1, PL2, Pe, U) = 0.5 mm.

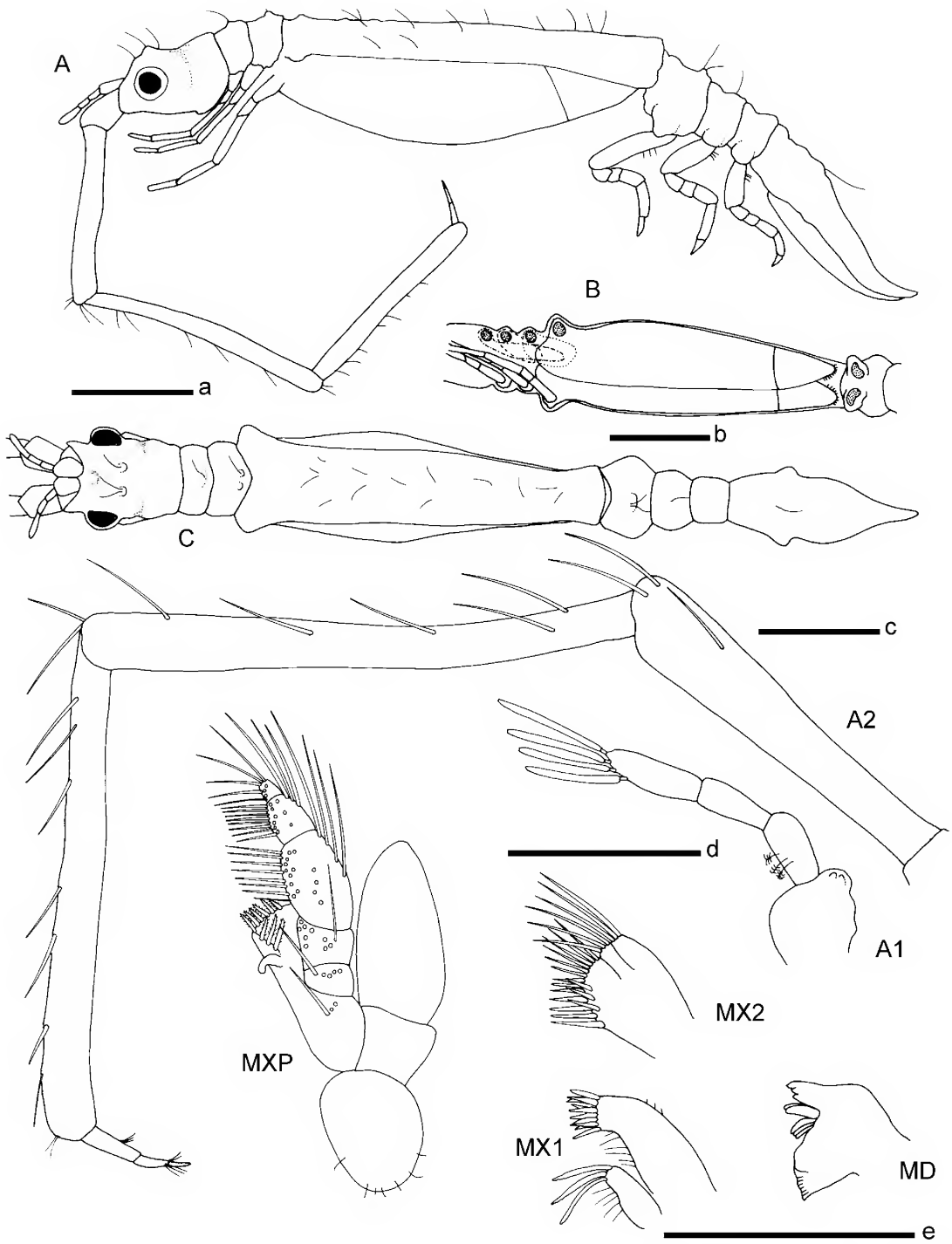

Figure 20. *Neastacilla soelae* sp. nov., female holotype (NMV J16652): A, lateral view; B, dorsal view; C, ventral view with oostegites; A1, A2, left MXP, MX1, MX2, MD. Scale: a (A, C) = 1.0 mm; b (B) = 1.0 mm; c (A2) = 0.5 mm; d (A1) = 1.0 mm; e (MXP, MX1, MX2, MD) = 0.5 mm.

posteriorly; unguis and secondary unguis present; secondary unguis less than half length of primary unguis. Uropod exopod with 2 setae distally. Oostegite 4 with suture at midlength.

11–17 mm.

Male. Pereonites, mouthparts, pereopods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose setae of unequal lengths. Pleopod 2 with appendix masculina with ridge on posterior face, apex simple, curved, not extending past the endopod. Penial plate widened proximally, apex simple.

8–15.5 mm

Distribution. Australia: Victoria, Tasmania; subtidal to 84 m depth.

Discussion. Guiler (1949) called the species '*monoseta*' because he found only one seta on the uropod exopod. This has subsequently been found to have been erroneous and every specimen examined for this redescription had two setae on the uropodal exopod. The best distinguishing characteristic for this species is its possession of an elongate distally acute pleotelson that flares out laterally into two acute wings.

Neastacilla sheardi (Hale)

Astacilla sheardi Hale, 1946: 183–184, fig. 13.
Neastacilla sheardi.—Poore et al., 2002: 259.

Diagnosis of female. Eyes small and subtriangular. Head with dorsal elevation (with 2 apices) slightly posterior to eyes, and small single dorsal elevation posteriorly; lateral margin of head and pereonite 1 not incised. Pereonite 1 with single small dorsal elevation. Pereonites 2–3 dorsally smooth, with small lateral expansions present. Pereonite about six times as long as pereonite 3, with anterolateral expansions, with pair of blunt dorsal elevations at midlength and blunt dorsal elevation posteriorly. Pereonites 5–7 dorsally smooth. Pleon as long as pereonites 5–7 combined, with 2 pairs of lateral wings, apex subacute. 5 mm.

Male. Unknown.

Distribution. Australia: South Australia (Spencer Gulf): subtidal.

Remarks. This species is diagnosed using the description of Hale (1946). believe that Hale's single specimen was an immature female, as the marsupium does not look to be fully formed. The specimen drawn by Hale (1946) is similar to *Neastacilla inaequispinosa* but can be easily distinguished from it by the much broader pleon, the shape and ornamentation of the head and slightly more robust antenna 2. If *N. sheardi* is found to be an immature specimen, on further examination, it may more closely resemble *N. marrimarri* or *N. tuberculata*.

Neastacilla soelae sp. nov.

Figures 20–21

Material examined. Holotype. Australia: WA, between Dampier and Port Hedland, 19°59.3'S, 117°03.6'E, 52 m, 22 Feb 1983, NMV J16652 (1 female, 7 mm).

Paratypes. Australia: **WA.** Between Dampier and Port Hedland, type locality, NMV J16930 (1 female, 8 mm); 19°27.2'S, 118°58.6'E, 36–46 m, 8 Dec 1982, NMV J40681 (1 female, 9 mm); 19°29.7'S, 118°52.2'E, 39 m, 24 Oct 1983, NMV J40682 (1 female, 7.5 mm); 19°56.7'S, 117°53.8'E, 43 m, 26 Aug 1983, NMV J40683 (1 female, 8.5 mm).

Description of female. Head with 2 dorsal elevations between eyes and smaller dorsal elevation anterior to eyes, with setae on elevations, anterolateral lobes angular, rostral point present; lateral margin of head and pereonite 1 not incised, with small flared anterolateral extension. Pereonite 2 with 1 dorsal tuberculate elevation with setae. Pereonite 3 with 2 dorsal elevations with setae. Pereonite 4 about 10 times as long as pereonite 3; with small tuberculate dorsal elevations with dorsal setae along length, anterolateral margins extended and rounded. Pereonites 5–7 with tuberculate elevations with setae. Pleon longer than combined lengths of pereonites 5–7; with small tuberculate dorsal elevations with dorsal setae, with lateral wings, long and tapering, apex acute.

Eyes small and round. Antenna 1 reaching past second peduncular article of antenna 2; aesthetascs present distally and laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 2 articles ending with claw, row of scales undetected.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 10 distal robust setae. Maxilla 2 mesial lobe with 16 plumose setae, middle lobe with 3 setae, lateral lobe with 3 setae. Maxillipedal endite with 9 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, articles 3 and 4 with mesial and lateral setal rows, article 5 with mesial and distal setae.

Pereopod 1 propodus slightly shorter than carpus; dactylus longer than wide; without unguis. Pereopods 2–4 without dactylus. Pereopods 5–7 dactylus not denticulate, with unguis and secondary unguis; secondary unguis setiform and slender, only slightly smaller than primary unguis. Uropodal exopod with 2 setae of equal length. Oostegite 4 with a posterior suture.

7–9 mm.

Male. Unknown.

Distribution. Australia: Western Australia; subtidal to 52 m depth.

Etymology. This species is named after the research vessel from which the specimen was collected, RV *Soela*.

Remarks. This species is from a region (north-western Australia) where little is known about the arcturid fauna. The long tapered pleotelson, loss of dactyli on pereopods 2–4 (a state possessed by *N. yuriel* sp. nov.) and the setose secondary dactlyus on pereopods 5–7 (also found in *N. lawadi* sp. nov.) characterise this species.

Neastacilla tarni sp. nov.

Figures 22–24

Material examined. Holotype. Australia: SA, Topgallant I., Investigator Group, 33°43.0'S, 134°36.6'E, 15 m, , K. Brandon and G.C.B. Poore, 21 Apr 1985, NMV J16579 (1 female, 6.0 mm).

Paratypes. Australia: **SA.** type locality, NMV J40676 (1 male, 7.0 mm); NMV J40677 (6 females, 4.5–5.0 mm; 7 males, 5.0–6.5 mm; 3 manca 2, 3.0–3.5 mm; 2 manca 1, 2.5 mm).

Description of female. Head with dorsal elevation (with 2 apices) posterior to eyes, anterolateral lobes angular, rostral point absent; lateral margin of head and pereonite 1 not incised.

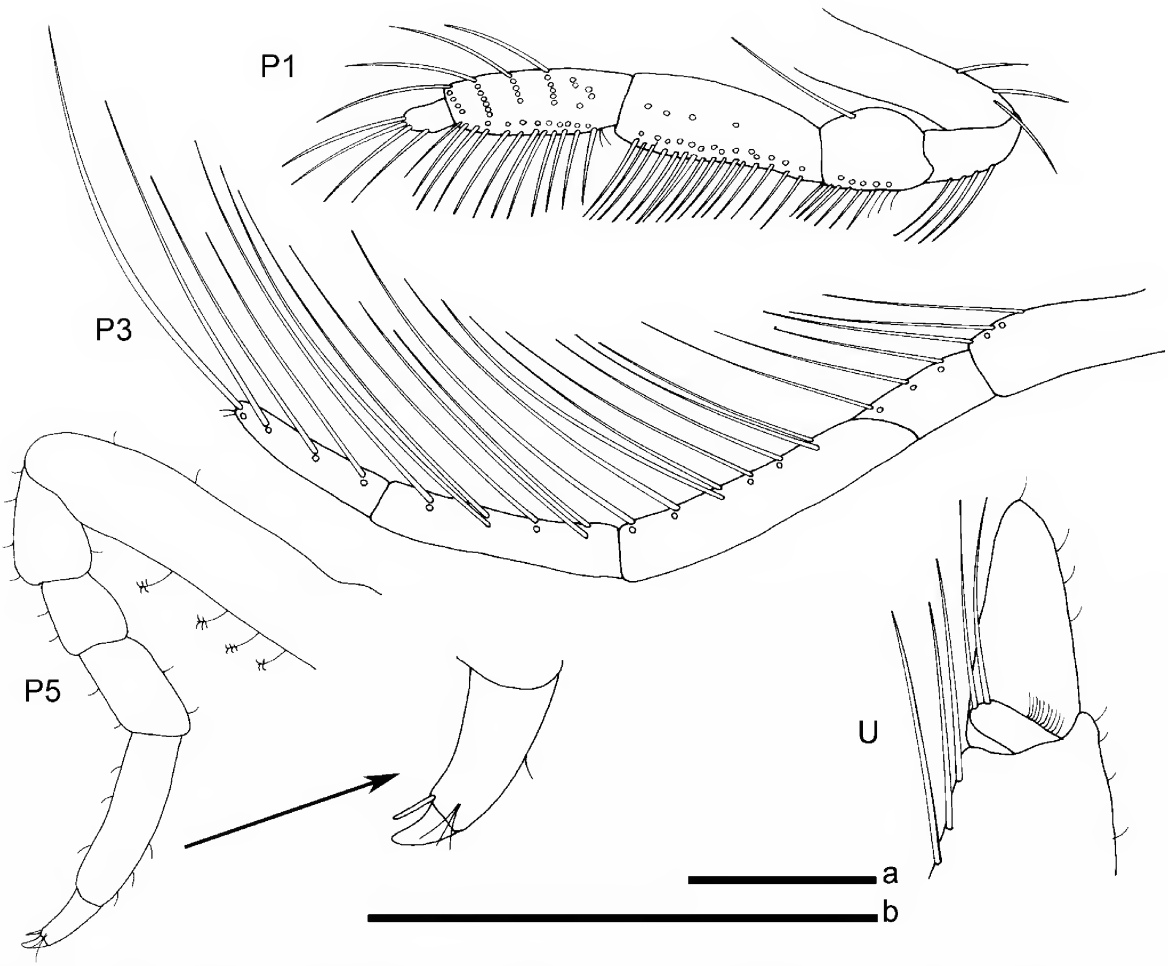

Figure 21. *Neastacilla soelae* sp. nov., female holotype (NMV J16652): P1, P3, P5, U. Scale: a (P1, P3) = 0.5 mm; b (U) = 0.5 mm

Pereonite 1 with posterior dorsal elevation. Pereonites 2 and 3 with dorsal and dorsolateral elevations, lateral margins extended. Pereonite 4 about 6 times as long as pereonite 3; with 2 dorsal elevations at midlength, 2 dorsolateral elevations posterior to them, a posterior dorsal elevation with 2 apices and 2 small dorsal elevations posteriorly; anterolateral margins extended and rounded. Pereonites 5–7 progressively shorter posteriorly, with small posterior dorsolateral and lateral elevations. Pleon longer than combined lengths of pereonites 5–7, with lateral wings, apex blunt.

Eyes small and subtriangular. Antenna 1 reaching to the end of the second peduncular article of antenna 2; aesthetascs present laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles ending in claw, 2 rows of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 9 distal robust setae. Maxilla 2 mesial lobe with 13 plumose setae, middle lobe with 4 setae, lateral lobe with 3 setae. Maxillipedal endite with 10 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, article 3 with mesial and lateral setal rows, article 4 with mesial and lateral setae, article 5 with distal setae.

Pereopod 1 propodus as long as carpus; dactylus slightly longer than wide, without unguis. Pereopods 2–4 with small dactylus. Pereopods 5–7 dactylus denticulate, with unguis and secondary unguis; secondary unguis half length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 with sutured small posterior lobe and thickened distolateral edges. A pair of fleshy pads are visible on the ventral surface of pereonite 5 that may be vestigial fifth oostegites.

4.5–6 mm.

Male. With less ornamentation than female. Head with 1 dorsal elevation between eyes. Pereonite 1 without dorsal elevations. Pereonites 2 and 3 without dorsal elevations. Pereonite 4 about 8 times as long as pereonite 3, constricted for the first quarter length, with 2 small elevations at quarter length and a

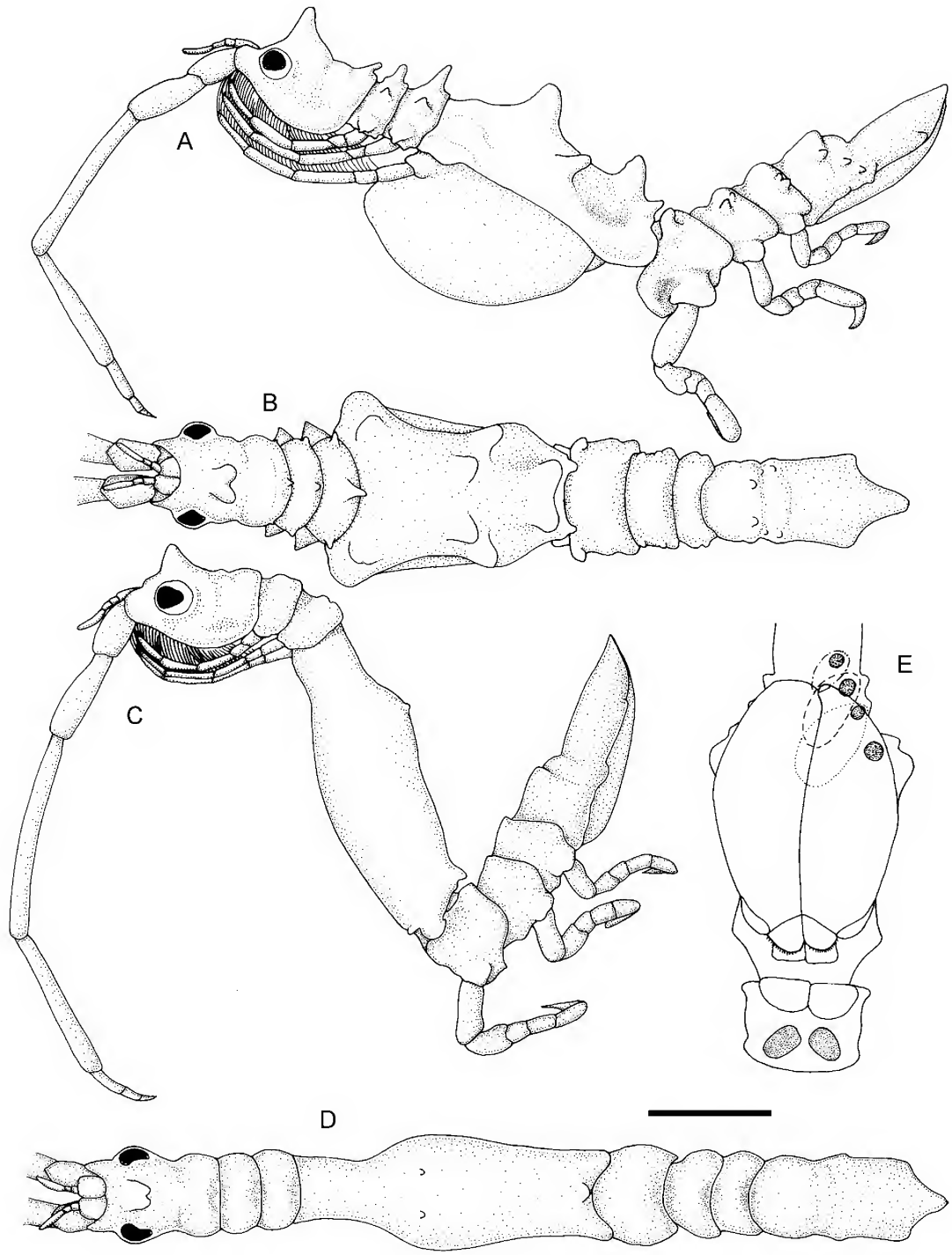

Figure 22. *Neastacilla tarni* sp. nov., female holotype (NMV J16579): A, lateral view; B, dorsal view; D, ventral view with oostegites. Male (NMV J40676): C, lateral view; E, dorsal view. Scale = 1.0 mm.

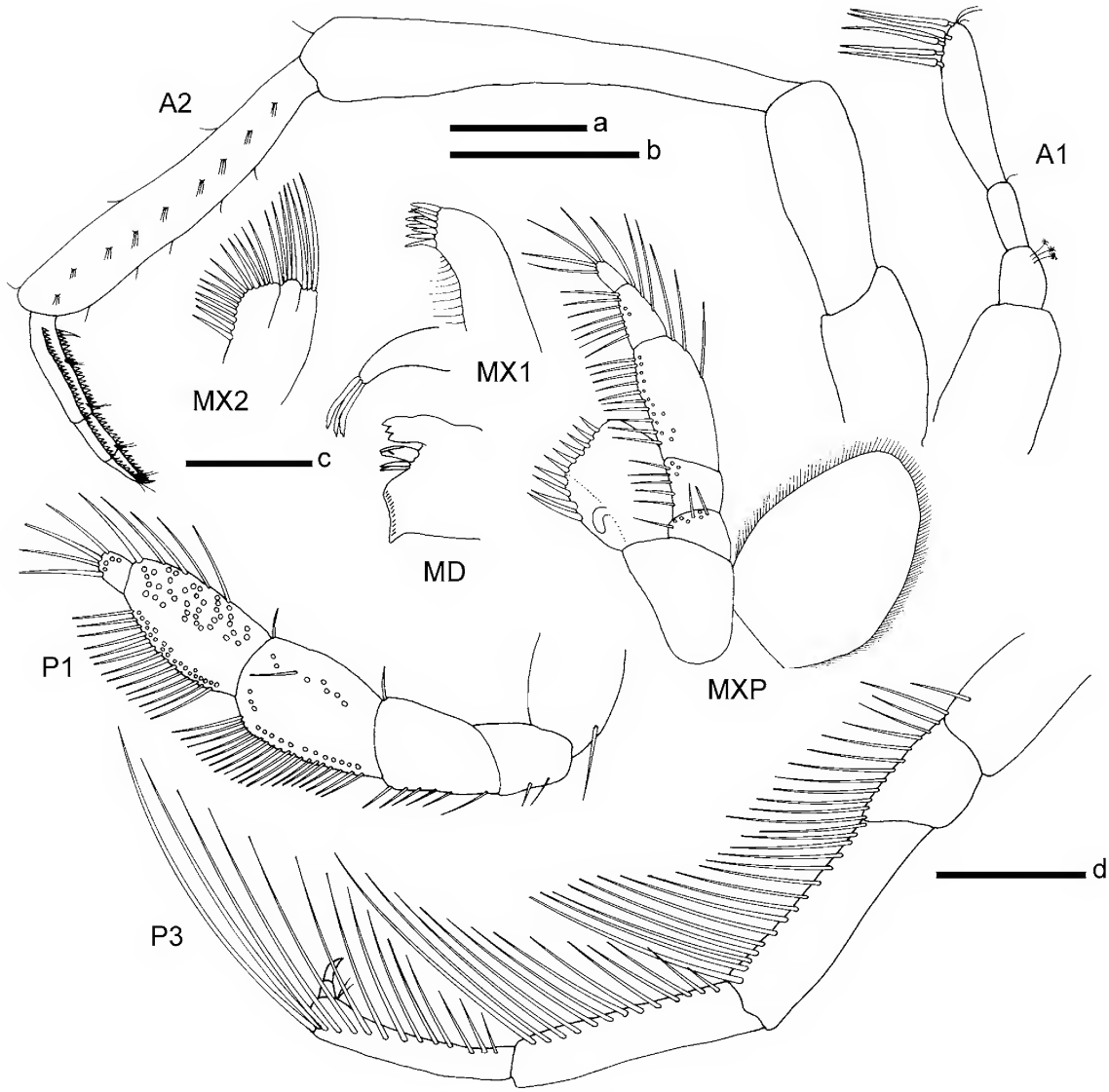

Figure 23. *Neastacilla tarni* sp. nov., female holotype (NMV J16579): A1, A2, left MXP, MX1, MX2, MD; P1, P3. Scales: a (A1) = 0.25 mm; b (A2) = 0.5 mm; c (MXP, MX1, MX2, MD) = 0.25 mm; d (P1, P3) = 0.5 mm.

posterior elevation. Pereonites 5–7 progressively shorter posteriorly, without dorsal elevations. Pleon longer than combined lengths of pereonites 5–7 , with lateral wings, apex blunt.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of equal length. Pleopod 2 appendix masculina with ridge on posterior face; curved; extending quarter length past the distal edge of the endopod; apex simple. Penial plate widened proximally, apex simple.

5–7 mm.

Distribution. Australia: South Australia; subtidal.

Etymology. "Tarni" is an Australian Aboriginal name from the Kaurna language group in South Australia. It means "the sea".

Remarks. The female of this species resembles *Neastacilla tuberculata* (Thomson, 1879) from New Zealand. However the arrangement of the dorsal tubercles on pereonite 4 and the shape of the pleotelson distinguish the two species; in N. tarni the dorsal tubercles are medially and posteriorly placed on pereonite 4 and the pleotelson is narrow and sculpted with a blunt apex, whereas in N. tuberculata the tubercles are in the

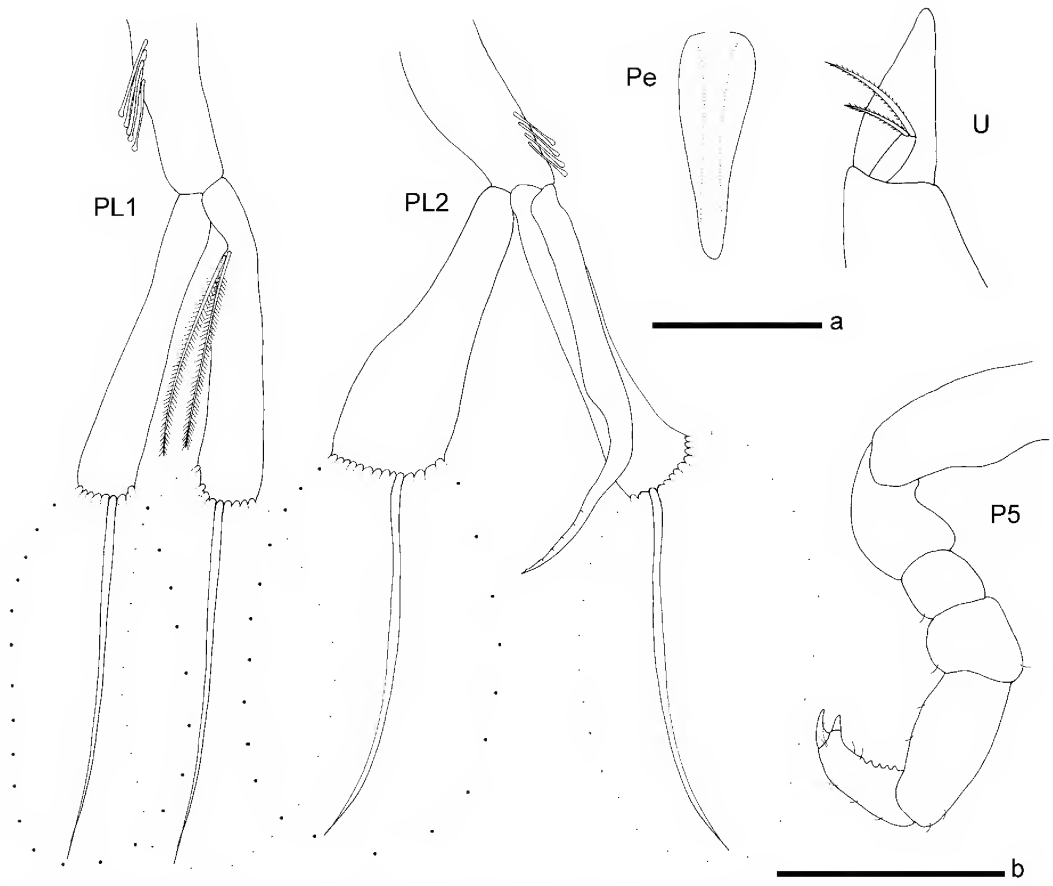

Figure 24. *Neastacilla tarni* sp. nov., female holotype (NMV J16579): P5, U. Male (NMV J40676): PL1, PL2, Pe. Scales: a (PL1, Pl2, Pe) = 0.2 mm; b (P5) = 0.5 mm.

anterior first half of pereonite 4 and the pleotelson is wide and tapered to an acute apex.

Neastacilla tattersalli Lew Ton and Poore

Neastacilla falclandica.—Tattersall, 1921: 244, pl. 10, fig. 1 (not Ohlin, 1901: 266, pl. 20).

Neastacilla tattersalli Lew Ton and Poore, 1986a: 193–195, fig. 3.—Lew Ton and Poore, 1986b: 99.—ICZN, 1987: 214.

Diagnosis of female. Eyes large and oval. Head without dorsal elevations, anterolateral lobes angular; lateral margin of head and pereonite 1 not incised. Pereonites 1–7 without dorsal elevations. Pereonites 2–4 with only small lateral expansions. Pereonite 4 9 times as long as pereonite 3. Pleon slightly longer than pereonites 5–7 combined, no distinct lateral wings present, apex bluntly rounded. Size unrecorded.

Male. Unknown.

Distribution. New Zealand, North Island.

Remarks. This species is diagnosed from the description of Lew Ton and Poore (1986) and most closely resembles *Neastacilla falclandica. N. tattersalli* can be distinguished from the former species by the long tapered pleon without lateral wings, angular anterolateral lobes of the head and the presence of two setae on the uropodal exopod.

Neastacilla tharnardi sp. nov.

Figures 25–27

Material examined. Holotype. Australia: Vic., Portland, Saxon Reef, 38°18.5'S, 141°38.5'E, 11 m, R. Wilson, 5 Mar 1992, NMV J24200 (1 female, 5 mm).

Paratypes. Australia: **SA.** Tiparra Bay, Tiparra Reef, 34°04.0'S, 137°23.0'E, 10 m, G.C.B. Poore and H.M. Lew Ton, 15 Mar 1985, NMV J16575 (1 male, 5 mm). Investigator Group, 33°43.0'S, 134°36.6'E, 20 m, K. Brandon and G.C.B. Poore, 21 Apr 1985, NMV J47326 (manca-2, 3 mm).

Description of female. Head with 2 dorsal elevations (each with 3 apices) between the eyes, anterolateral lobes angular with small tubercles, small rostral point present; lateral margin of head and pereonite 1 incised. Pereonite 1 with dorsal elevation

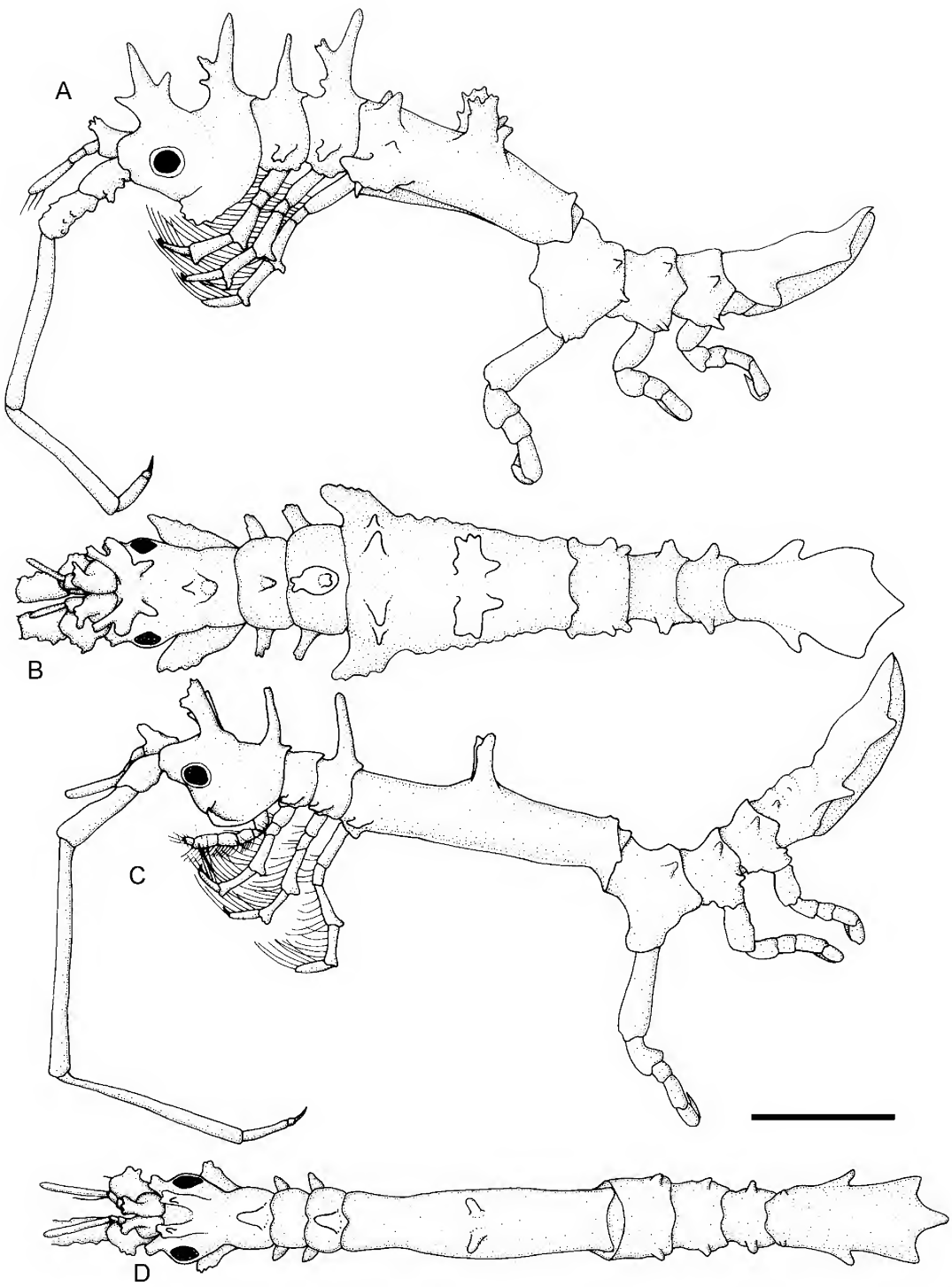

Figure 25. *Neastacilla tharnardi* sp. nov., female holotype (NMV J24200): A, lateral view; B, dorsal view. Male (NMV J16575): C, ventral view; D, dorsal view. Scale = 1.0 mm.

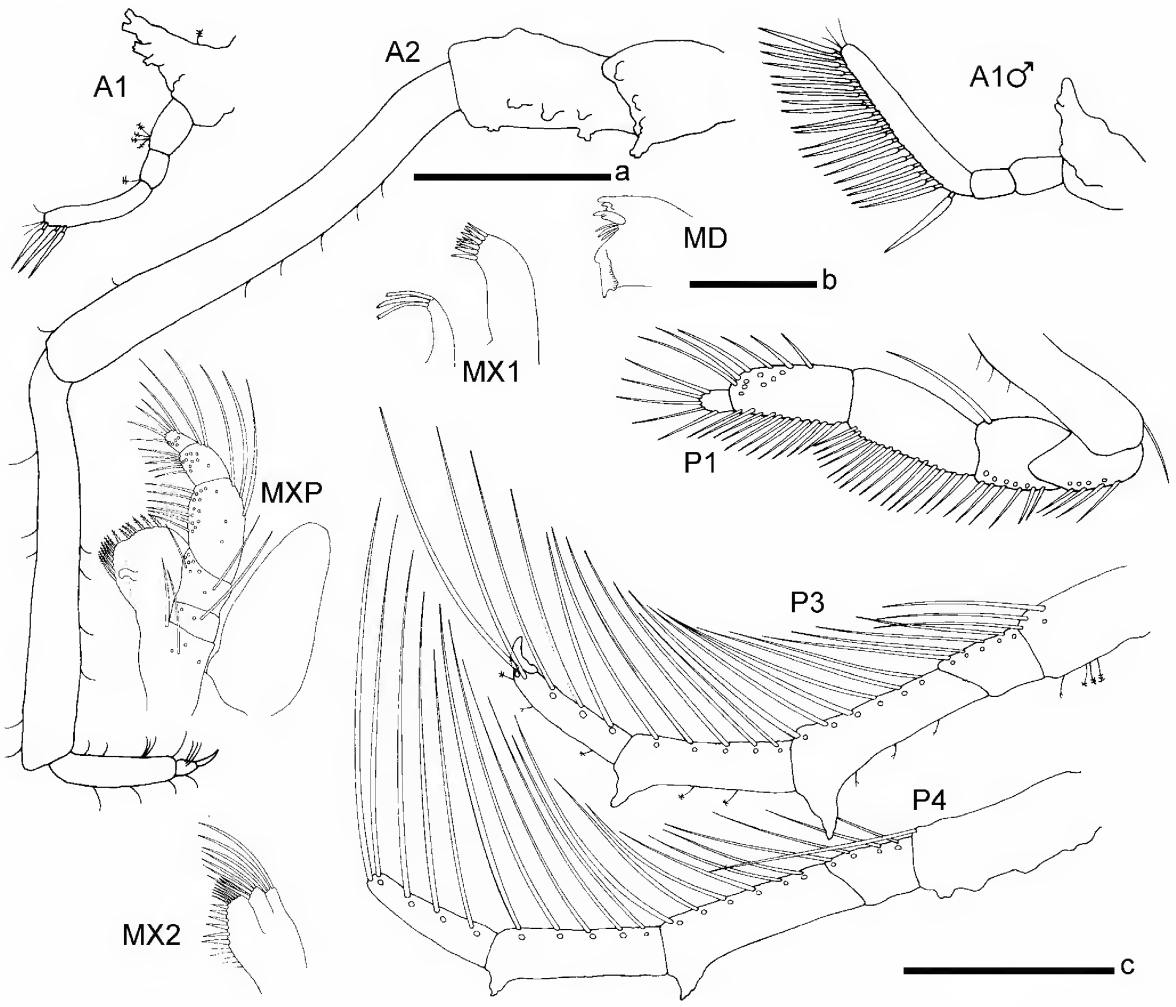

Figure 26. *Neastacilla tharnardi* sp. nov., female holotype (NMV J24200): A1, A2, left MXP, MX1, MX2, MD; P1, P3, P4. Male (NMV J16575): A1♂. Scales: a (A1, A1♂, A2) = 0.5 mm; b (MXP, MX1, MX2, MD) = 0.2 mm; c (P1, P3, P4) = 0.5 mm.

with 3 apices; with large, laterally curved anterolateral expansion. Pereonite 2 with dorsal elevation with single apex, with narrow lateral extensions. Pereonite 3 with dorsal elevation with 3 apices, with narrow lateral extensions. Pereonite 4 about 4 times as long as pereonite 3, with 4 anterior dorsal elevations, 2 dorsal elevations with many apices at midlength and 2 small dorsal elevations posteriorly, with anterolateral margins extended. Pereonites 5–7 progressively smaller, with small posterior dorsolateral elevations. Pleon longer than combined lengths of pereonites 5–7, with lateral wings, apex acute.

Eyes small and round. Antenna 1 reaching to the end of the third peduncular article of antenna 2; aesthetascs present laterally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of two articles and claw, second article very small, with a row of scales along full length.

Maxilla 1 mesial lobe with 3 terminal setae; lateral lobe with 10 distal robust setae. Maxilla 2 mesial lobe with 14 plumose setae, middle lobe with 4 setae, lateral lobe with 3 setae. Maxillipedal endite with 14 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, article 3 with mesial and lateral setal rows, article 4 with mesial and lateral setae, article 5 with mesial and distal setae.

Pereopod 1 propodus as long as carpus; dactylus slightly longer than wide, without unguis. Pereopods 2 and 3 with small dactylus. Pereopod 4 without dactylus. Pereopods 2–4 slightly dorsoventrally flattened, with tuberculate lateral elevations at proximal edges of the merus and carpus. Pereopods 5–7 dactylus not denticulate, with primary and secondary unguis; secondary unguis half length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 without a

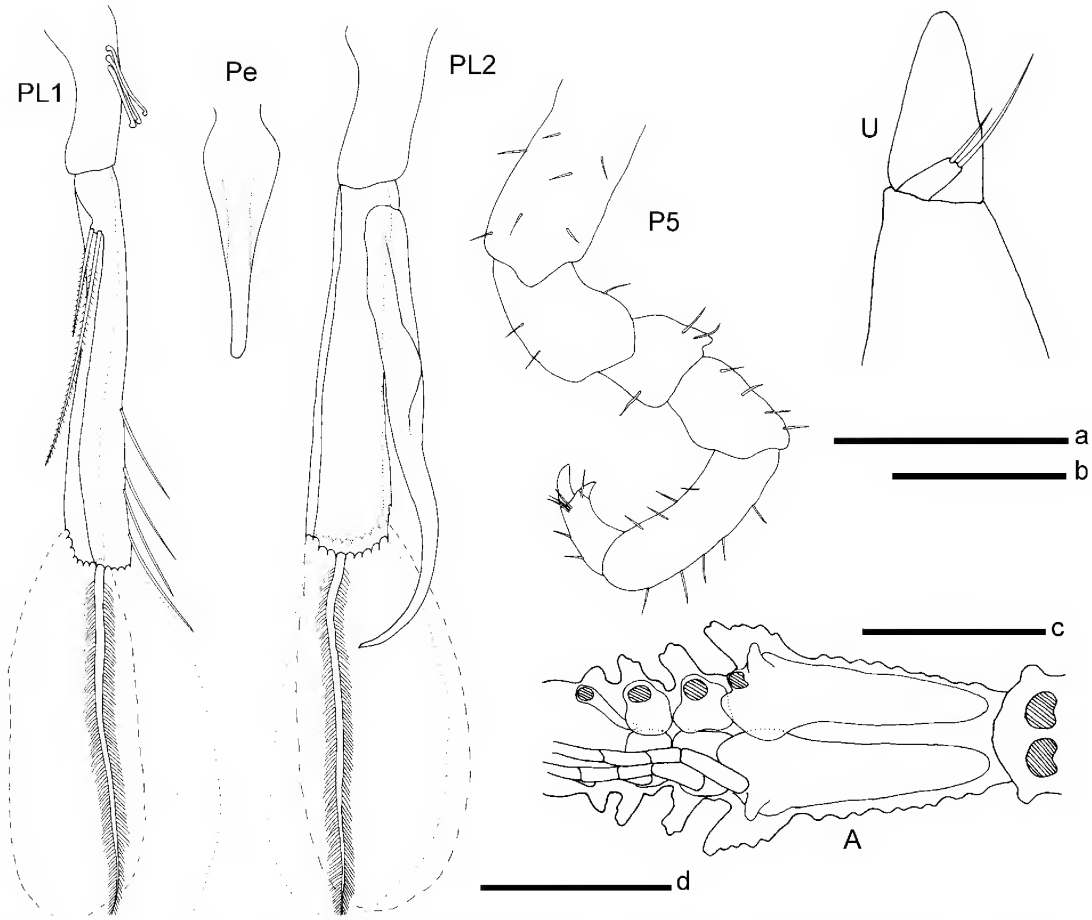

Figure 27. *Neastacilla tharnardi* sp. nov., male (NMV J16575): PL1, PL2, Pe. Female holotype (NMV J24200): U; A, ventral view with oostegites. Scales: a (U) = 0.5 mm; b (P5) = 0.5 mm; c (A) = 1.0 mm; d (PL1, PL2, Pe) = 0.5 mm

suture, with ventrally projecting elevation posterior to insertion of pereopod 4.

5 mm.

Male. With less ornamentation than female. Head with 2 dorsal elevations (each with 2 apices) between eyes, anterolateral margins angular with small tubercles. Pereonite 1 with dorsal elevation with a single apex. Pereonite 2 without dorsal elevations, with lateral extensions. Pereonite 3 with dorsal tubercle with single apex, with lateral extensions. Pereonite 4 about 7 times as long as pereonite 3, constricted for the first quarter length; with 2 anterior dorsal elevations at midlength. Pereonites 5–7 progressively smaller, with small posterior dorsolateral elevations. Pleon longer than combined lengths of pereonites 5–7, with lateral wings, apex acute.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of unequal length. Pleopod 2 appendix masculina with ridge on posterior face; curved; extending quarter length past the endopod; apex simple. Penial plate proximally widened, distally tapered and apex simple.

5 mm.

Distribution. Australia: Victoria, South Australia; subtidal to 20 m depth.

Etymology. "Tharnardi" is an Australian Aboriginal word in the Yindjibarndi language from north-western Australia. It means "the sea".

Remarks. This species of *Neastacilla* superficially most resembles species of *Parastacilla* Hale, 1946 (King, 2000). The lateral extension of the head and pereonite 1 as well as the morphology of the anterior pereonites are very similar and no other *Neastacilla* species. However, in *N. tharnardi* pereopods 2 and 3 possess dactyli with claws, antenna 2 is elongate and there are no dorsolateral wings on the pleotelson.

Neastacilla tuberculata (Thomson)

Figures 28–29

Arcturus tuberculatus Thomson, 1879: 416–417, pl. 19 figs 1–4.—Thomson, 1881: 206, pl. 7 fig. 2.—Thomson and Chilton, 1886: 156.—Filhol, 1885, 437. (not Arcturus tuberculatus Latreille, 1829, junior synonym of Arcturus baffini Sabine).

Astacilla tuberculata.—Hurley, 1961: 264.

Neastacilla tuberculata.—Poore, 1981: 333.

Material examined. New Zealand: Lyttelton Harbour, 5 m, Aug 1997, NMV J40643 (1 male, 4.5 mm). Otago Harbour, 12.1 m, 4 Oct 1965, NMV J16559 (1 female, 4.5 mm), NMV J16560 (1 male, 4 mm), NMV J16558 (1 female, 5 mm) NMV J16562 (1 male, 5 mm). Otago Harbour, 6 m, 18 Jun 1965, NMV J 16560 (3 females, 4–4.5 mm; 5 males, 3.5–5 mm; 2 juveniles, 3 mm). Otago Harbour, 13 m, 30 Apr 1965, NMV J16561 (1 male, 5 mm). Otago Harbour, 13 m, 4 Oct 1965, NMV J16556 (1 female, 5 mm). Otago Harbour, 4.1 m, 13 Jun 1965, NMV J12927 (1 female, 4 mm). Otago Harbour, 2.9 m, 7 Jan 1967, NMV J40644 (1 female, 4.5 mm). The Snares, 146 m, 26 Nov 1974, NMV J16557 (1 male, 4.5 mm).

Description of female. Head with 2 dorsal elevations between eyes, small dorsal elevation in front of eyes and an elevation posterior to eyes on dorsal midline, anterolateral margins angular, rostral point absent. Lateral margin of head and pereonite 1 not incised. Pereonite 1 with 2 elevations along dorsal line and pair of dorsolateral elevations. Pereonites 2 and 3 progressively wider; with dorsal and dorsolateral elevations, anterolateral margins extended. Pereonite 4 about 7 times as long as pereonite 3, with a large dorsal elevation (with 3 apices) covering the first two-thirds length, small anterior dorsolateral elevations,dorsolateral elevations at midlength, a posterodorsal elevation on the dorsal line and 2 small dorsolateral elevations posterior to that, with anterolateral margins rounded and extended. Pereonites 5–7 progressively smaller, with small dorsal and dorsolateral elevations, lateral margin extended. Pleon longer than combined lengths of pereonites 5–7 , with 2 sets of lateral wings, with small dorsal and dorsolateral elevations, flared posteriorly and tapering to acute apex.

Eyes small and round. Antenna 1 reaching to the end of third peduncular article of antenna 2; aesthetascs attached laterally and distally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles and claw, with row of scales along full length.

Maxilla 1 inner lobe with 3 terminal setae; outer lobe with 10 distal robust setae. Maxilla 2 inner lobe with 18 plumose setae, middle lobe with 3 setae, outer lobe with 3 setae. Maxillipedal endite with 14 mesial setae; 1 coupling hook; palp article 2 with mesial setal rows, article 3 with mesial and lateral setal rows, article 4 with mesial setae, article 5 with mesial and distal setae.

Pereopod 1 propodus as long as carpus; dactylus slightly longer than wide, without unguis. Pereopods 2–4 with small dactylus. Pereopods 5–7 progressively smaller; dactylus denticulate, with unguis and secondary unguis; secondary unguis half length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 with sutured small posterior lobe.

4–5 mm.

Male. With less ornamentation than female. Head with 2 dorsal elevations (sometimes fused) between eyes; anterolateral margins angular; rostral point absent; lateral margin of head and pereonite 1 not incised. Pereonite 1 with small dorsal and dorsolateral elevations. Pereonite 2 and 3 with dorsal and dorsolateral elevations. Pereonite 4 about 6 times as long as pereo-nite 3; with an anterior dorsal elevation at third length, a small posterior dorsal elevation and 2 small posterior dorsolateral elevations. Pereonites 5–7 progressively smaller without distinct dorsal elevations except for pereonite 5 which has a small posterior dorsal elevation. Pleon longer than combined lengths of pereonites 5–7, with 2 sets of lateral wings, with small dorsal elevations, tapering to an acute apex.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose lateral setae of equal length. Pleopod 2 appendix masculina with ridge on posterior face; curved; extending more than third length past the endopod; apex tapered. Penial plate simple and straight.

3.5–5.0 mm.

Distribution. New Zealand; subtidal to 201 m depth.

Remarks. This species was briefly described by Thomson (1879) who illustrated only the lateral view of a female. The highly ornamented body, particularly the dorsally elevated pereonite 4, makes it distinguishable from other New Zealand arcturids.

Neastacilla yuriel sp. nov.

Figures 30–32

Material examined. Holotype. Australia: SA, Flinders I., Hotspot Reef, 33°40.5'S, 134°22.0'E, 17 m, G.C.B. Poore, SCUBA, 19 Apr 1985, NMV J16553 (1 female, 3.5 mm).

Paratypes. Australia: **SA,** collected with holotype, NMV J40678 (1 female, 3 mm), NMV J40693 (1 male, 3.5 mm), NMV J40694 (1 male, 4 mm), NMV J16554 (4 females, 3.5–4 mm), NMV J16549 (1 male, 3.5 mm). Flinders I., Hotspot Reef, 33°40.8'S, 134°22.5'E, 21 m, 20 Apr 1985, NMV J16547 (manca 2, 3 mm). Topgallant I., 33°43.0'S, 134°36.6'E, 25 m, 21 Apr 1985, NMV J16546 (1 male, 3 mm); 33°43.0'S, 134°36.6'E, 12 m, 21 Apr 1985, NMV J16548 (2 females, 3–3.5 mm; 2 males, 4 mm; manca 2, 2.5 mm). **Vic.** Central Bass Strait, 38°33.4'S, 144°54.9'E, 55 m, 12 Nov 1981, NMV J8853 (1 male, 4 mm). Tas. Spiky Bridge coastal reserve, 42°08.0'S, 148°08.0'E, 4 m, 21 Mar 1988, NMV J40648 (1 female, 3.5 mm; 2 manca 2, 2.5 mm). Bicheno, 41°53.0'S, 147°18.0'E, 7 m, 23 Mar 1988, NMV J40645 (1 female, 4 mm). **WA.** Breaksea I., 35°03.9'S, 118°02.9'E, 15 m, 7 Apr 1984, NMV J16632 (2 females, 3 mm; 1 male, 3.5 mm). King George Sound, 35°00.7'S, 118°10.1'E, 27 m, 15 Apr 1984, NMV J16630 (1 female, 3 mm).

Description of female. Head with dorsal elevations slightly posterior to the eyes, anterolateral margins angular, small rostral point present; lateral margin of head and pereonite 1 not incised. Pereonite 1 with 2 indistinct dorsolateral elevations. Pereonites 2 and 3 with indistinct dorsal elevations, with lateral margins extended. Pereonite 4 about 7 times as long as pereonite 3, with large dorsal elevation at midlength, anterolateral margins rounded and extended. Pereonites 5–7 progressively smaller, without distinct elevations. Pleon longer than combined lengths of pereonites 5–7, with 2 sets of lateral wings, without dorsal elevations, tapering to subacute apex.

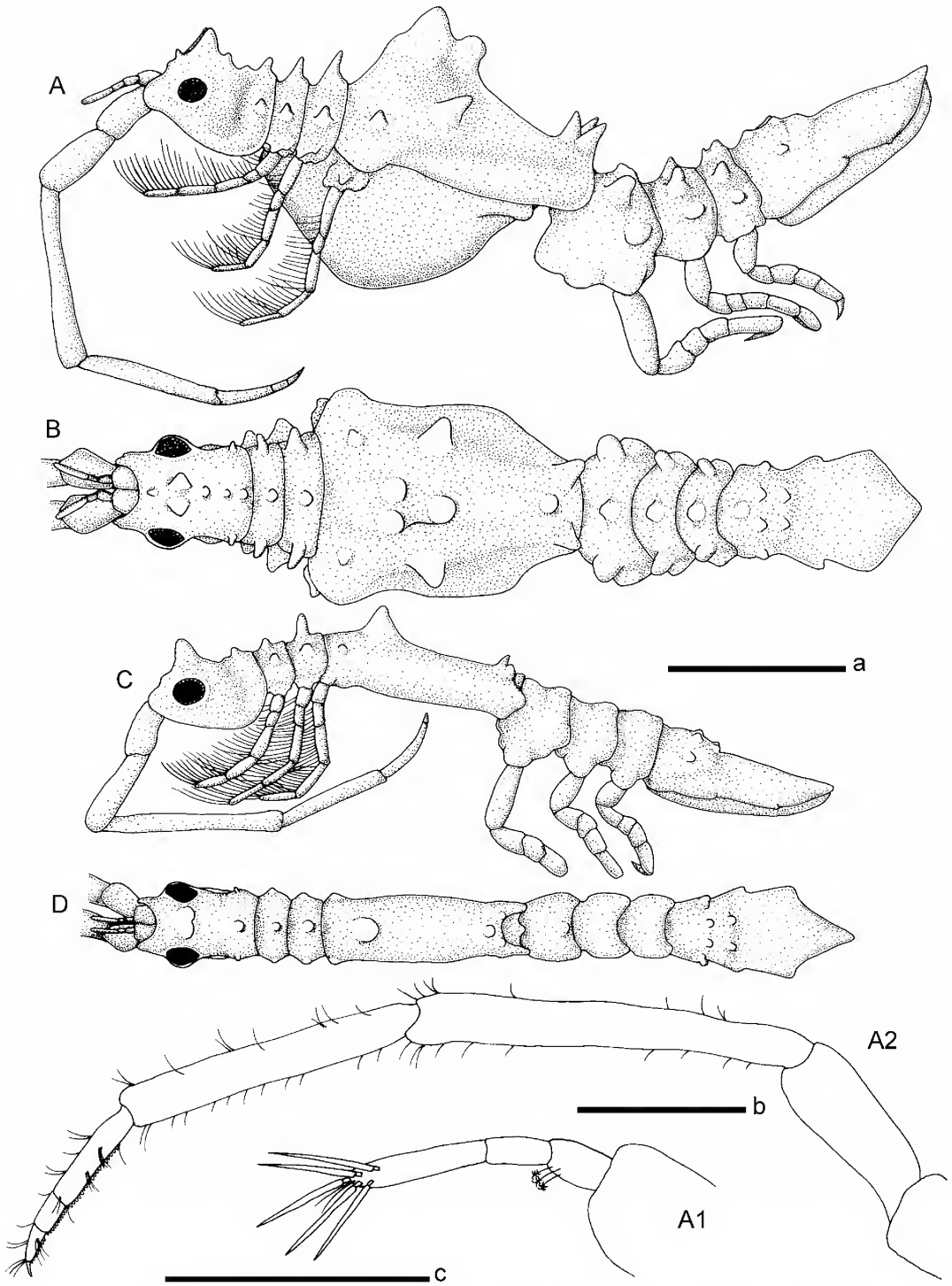

Figure 28. *Neastacilla tuberculata* (Thomson, 1879), female (NMV J16559): A, lateral view; B, dorsal view; A1, A2, antenna 2. Male (NMV J16560): C, lateral view; D, dorsal view. Scales = a (A–D) = 1.0 mm; b (A2) = 0.5 mm; c (A1) = 0.5 mm.

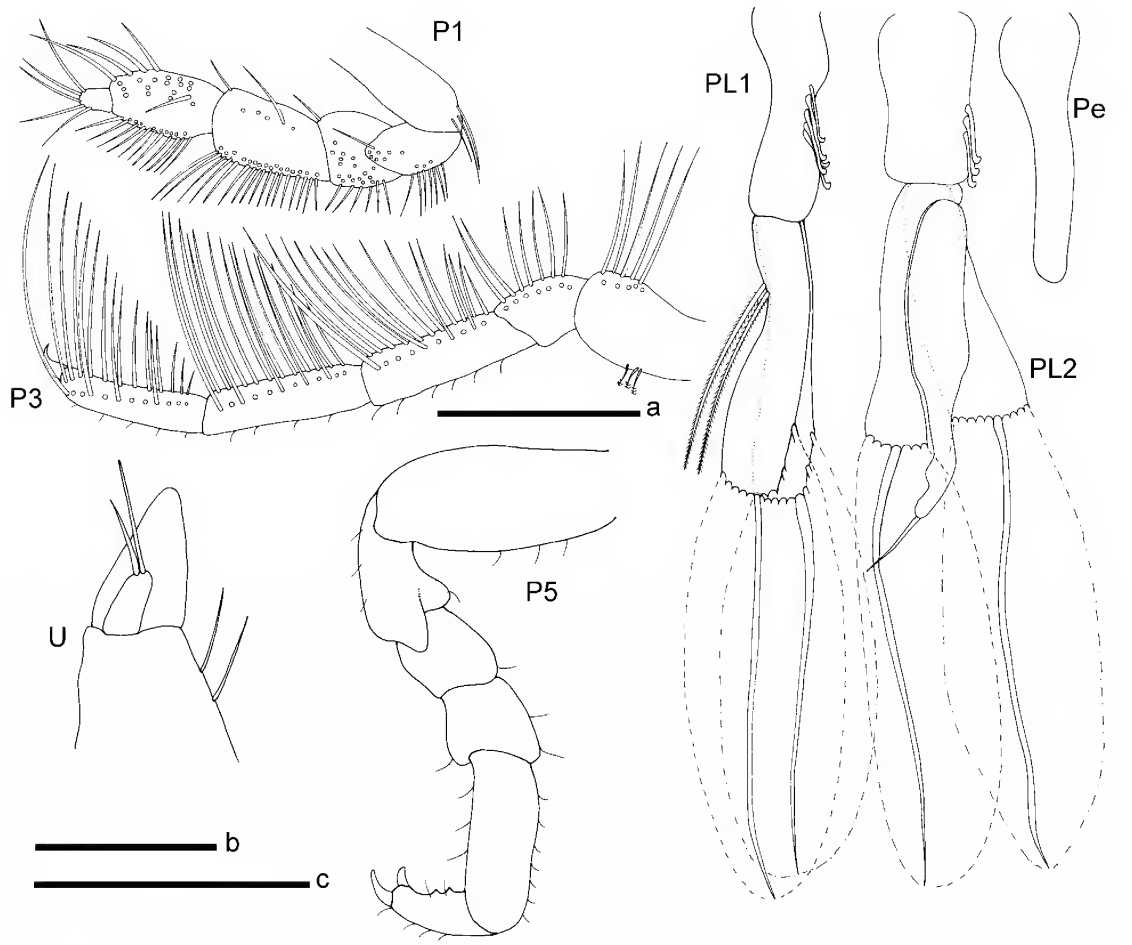

Figure 29. *Neastacilla tuberculata* (Thomson, 1879), female (NMV J16559): P1, P3, P5, U. Male (NMV J16560): PL1, PL2, Pe Scales: a (P1, P3) = 0.5 mm; b (P5) = 0.5 mm; c (PL1, PL2, Pe) = 0.5 mm.

Antenna 1 reaching to end of third peduncular article of antenna 2; aesthetascs present laterally and distally on flagellum. Antenna 2 slender, more than half as long as body; flagellum of 3 articles and claw; with row of scales along full length.

Maxilla 1 inner lobe with 3 terminal setae; outer lobe with 10 distal robust setae. Maxilla 2 inner lobe with 18 plumose setae, middle lobe with three setae, outer lobe with three setae. Maxillipedal endite with 14 mesial setae; one coupling hook; palp article 2 with mesial setal rows, article 3 with mesial and lateral setal rows, article 4 with mesial setae, article 5 with mesial and distal setae.

Pereopod 1 propodus as long as carpus; dactylus slightly longer than wide, without unguis. Pereopods 2–4 with small dactylus. Pereopods 5–7 progressively smaller, dactylus denticulate; with primary and secondary unguis; secondary unguis half length of primary unguis. Uropodal exopod with 2 setae of subequal length. Oostegite 4 with sutured small posterior lobe. 3–4 mm.

Male. With less ornamentation than female. Head with indistinct dorsal elevation between eyes, anterolateral margins angular, very small rostral point present; lateral margin of head and pereonite 1 not incised. Pereonite 1 with indistinct dorsal and dorsolateral elevations. Pereonite 2 and 3 with indistinct dorsal elevations, lateral margins not extended. Pereonite 4 about 6 times as long as pereonite 3; constricted in dorsal view for first fifth of length, with 2 small posterior dorsal elevations at midlength. Pereonites 5–7 progressively smaller, without dorsal elevations. Pereonites 6 and 7 without dorsal elevations. Pleon longer than combined lengths of pereonites 5–7, with 2 sets of lateral wings, with small dorsal elevations, tapering to a subacute apex.

Antennae, mouthparts, pereopods and uropods as for female.

Pleopod 1 exopod with lateral notch and 2 plumose setae of equal length. Pleopod 2 appendix masculina with ridge on

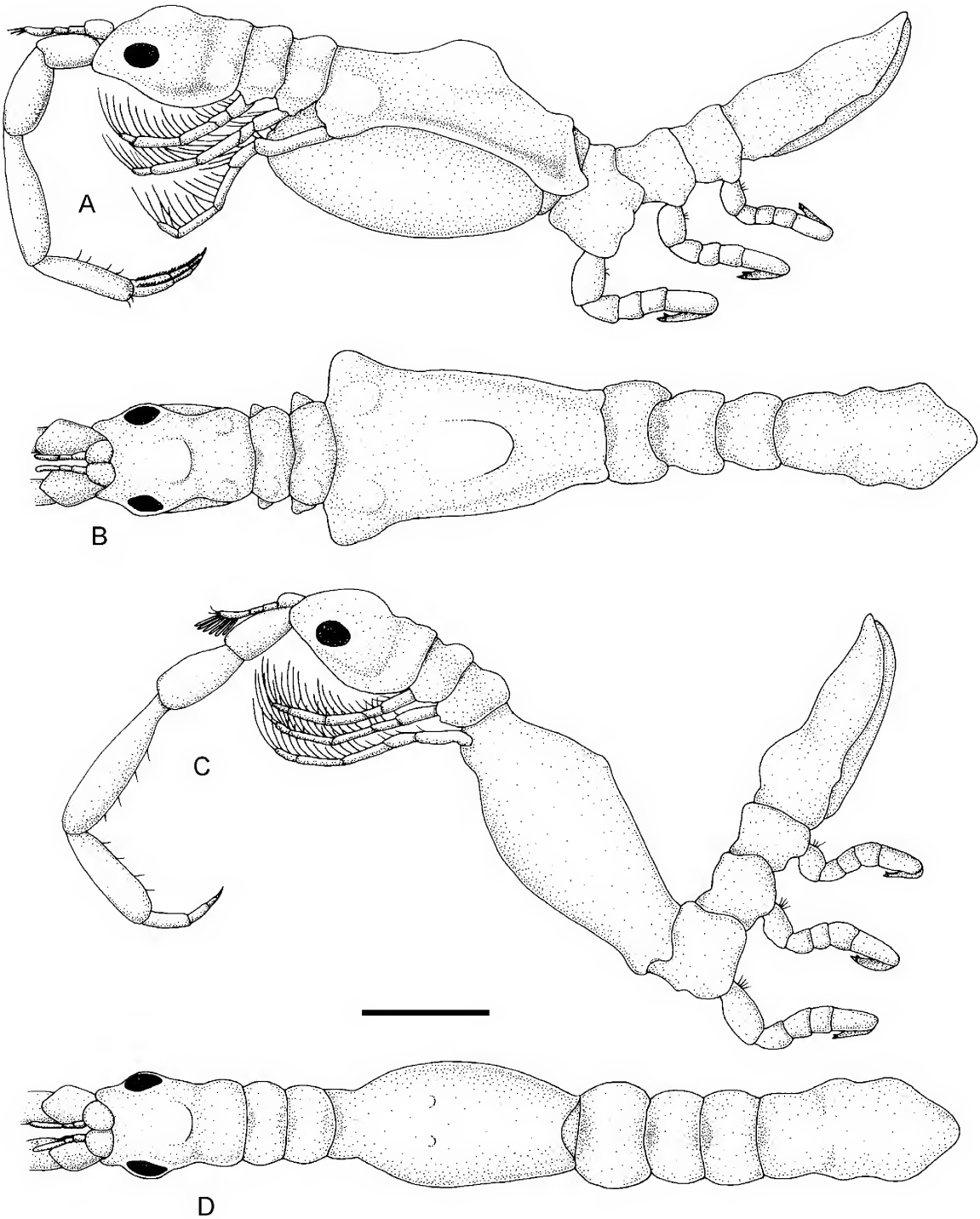

Figure 30. *Neastacilla yuriel* sp. nov., female holotype (NMV J16553): A, lateral view; B, dorsal view. Male (NMV J40693): C, lateral view; D, dorsal view. Scale = 1.0 mm.

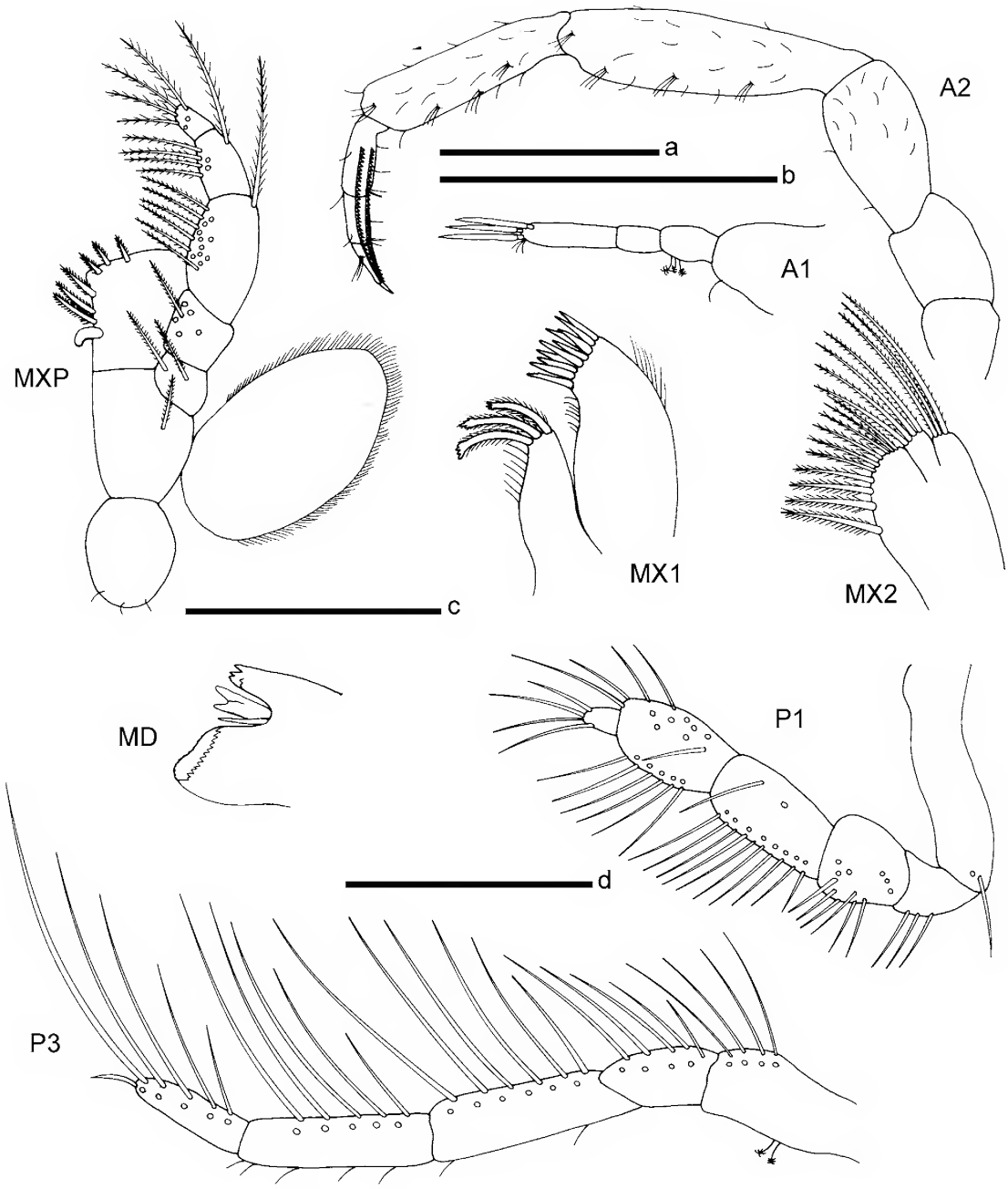

Figure 31. *Neastacilla yuriel* sp. nov., female holotype (NMV J16553): A1, A2, left MXP, MX1, MX2, MD; P1, P3. Scales: a (A2) = 0.5 mm; b (A2) = 0.5 mm; c (MXP, MX1, MX2, MD) = 0.5 mm; d (P1, P3) = 0.5 mm.

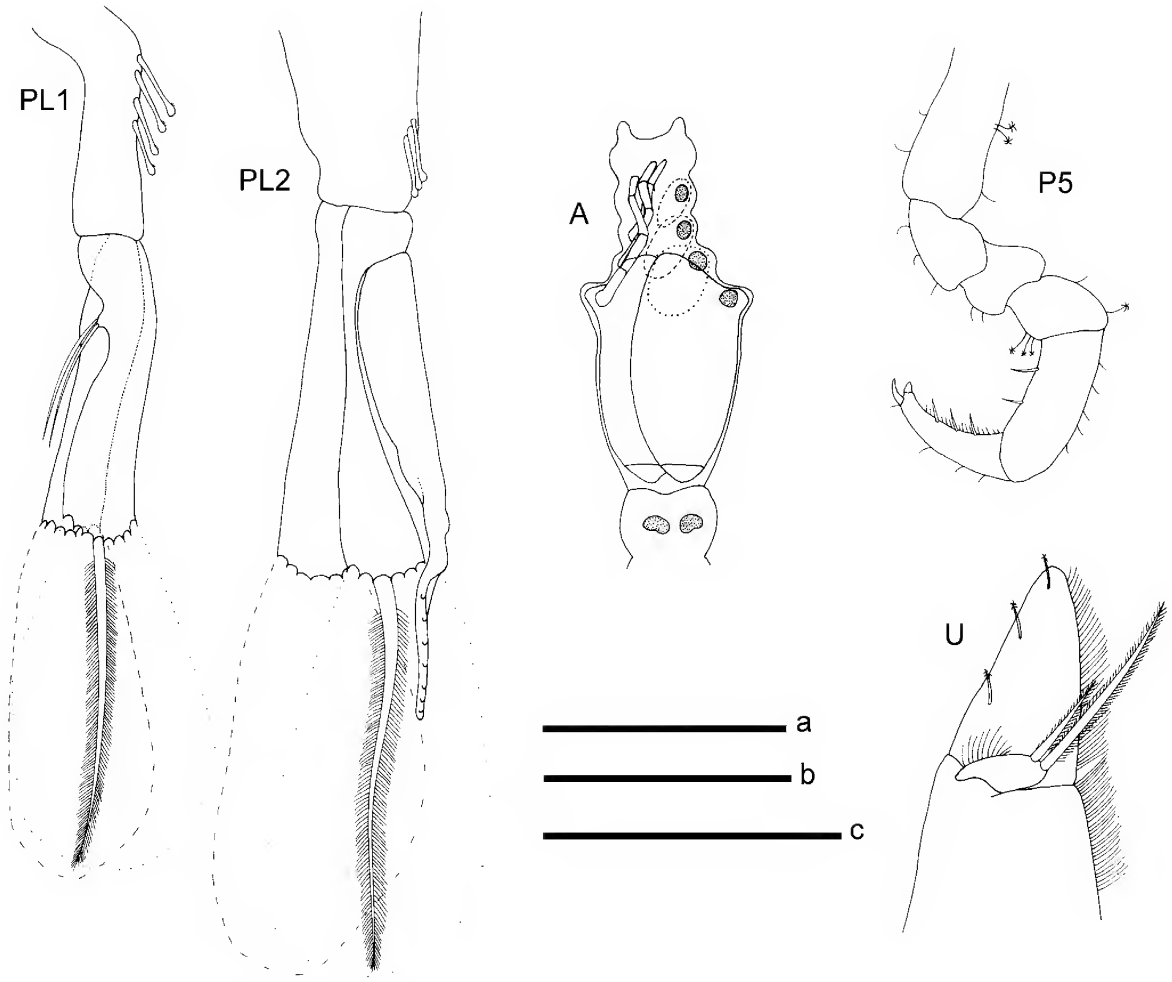

Figure 32. *Neastacilla yuriel* sp. nov., male (NMV J40693): PL1, PL2, pleopod 2. Female holotype (NMV J16553): U; A, ventral view with oostegites; P5. Scales: a (A) = 1.0 mm; b (P5) = 0.5 mm; c (PL1, PL2, Pe, U) = 0.2 mm.

posterior face; curved; extending third length past endopod; apex simple. Penial plate unknown.

Distribution. Australia: Victoria, Tasmania, South Australia, Western Australia; subtidal to 55 m depth.

Etymology. "Yuriel" is an Australian Aboriginal word for "coastal bay" in reference to the area specimens were first taken from.

Remarks. This species is the smallest of the Australian arcturids (2.5–4 mm) making the species instantly recognisable. The ornamentation of females has been seen to differ slightly within populations. In a few specimens the dorsal elevation on pereonite 4 possessed two apices and the small elevations on the head and pereonites 1–4 were more enlarged.

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This work was conducted as part of a postgraduate degree at the University of Melbourne and Museum Victoria with funding from an Australian Postgraduate Award. I am extremely grateful to Dr Gary Poore for encouragement and advice and also to the staff and students at Museum Victoria for support. I thank Helen Lew Ton, whose unpublished honours thesis provided a basis for this study of *Neastacilla* and Professor Alan Myers for helpful suggestions on the manuscript.

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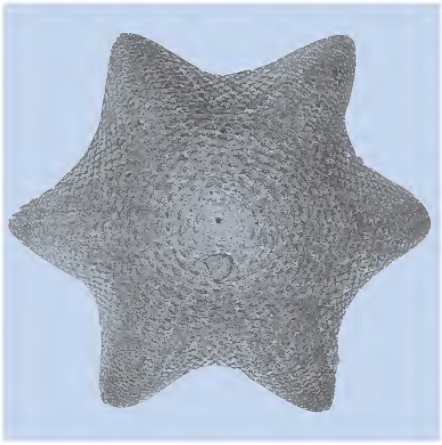

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